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WATER RESOURCES DIVISION

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NATURAL RESOURCES REPORT NPS/NRWRD/NRR-92/07

U.S. Department of the Interior
National Park Service

The National Park Service Water Resources Division is responsible for providing water resources management policy and guidelines, planning, technical assistance, applied research, training, and operational support to units of the National Park System. Program areas include water rights, water resources planning, regulatory guidance and review, hydrology, water quality, watershed management, watershed studies, and aquatic ecology.

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February 1992

U.S. DEPARTMENT OF THE INTERIOR
National Park Service
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A WORD FROM THE ASSOCIATE DIRECTOR, NATURAL RESOURCES

by F. Eugene Hester

This annual report provides you with a summary of significant accomplishments of the Water Resources Division (WRD) during 1991. The WRD, which is headquartered in Fort Collins, Colorado with additional program offices in Washington, D.C., and Denver, Colorado, provides servicewide leadership for the preservation and protection of National Park Service (NPS) water resources and associated values. The Division carries out a broad-based water resources program involving a variety of activities including planning and regulatory assessment, water rights, water quality, floodplains, wetlands, watershed protection, information resources management, and applied research. In addition to national program leadership, the Division provides day-to-day support to parks, regions, the Washington Office, and other NPS organizational units.

I appreciate the continued strong cooperation of regional and park staffs throughout the Service during this past year. That support has provided an environment for the high level of success achieved by our natural resources program.

COMMENTS FROM THE DIVISION CHIEF

by Stan Ponce

1991 was a very productive year for the WRD, characterized by some very significant accomplishments. Additional resources, both human and financial, were secured, thus, enabling us to enhance our technical and project support servicewide, particularly in the areas of water rights, water quality, wetlands, data management and Geographic Information System (GIS), and hazardous materials assessment. The WRD Report Series received strong support from the field and implementation of internal controls resulted in improved program accountability. Outreach activities elevated WRD program recognition throughout the Federal community and improved coordination with other NPS organizational units.

Base funding for the Division increased by $1.2 million, bringing the Division's total FY92 budget to $6,104,000. This year's increase was primarily dedicated to water rights issues. The WRD prioritized projects received a total of $758,500 this year, of which $627,500 funded continuing projects leaving $131,000 available for new starts in FY92. Projects funded through the Watershed Protection Program totaled $427,800, representing $336,100 in water quality projects and $156,700 in wetlands projects. The Watershed Research Program continued to be funded at $395,000 and the Division again received $500,000 for water resource studies at Everglades National Park. In addition, the Applied Research Branch received $161,000 for park-related research and the Division is funding studies totaling $985,000 in support of water rights needs. In summary, the WRD provided $3.3 million in direct support of water resources studies at parks which represents nearly 54 percent of our annual operating budget.

The WRD had some very significant program accomplishments this year. Below are some examples of the contributions made by the WRD for resolving significant resource issues:

- WRD staff conducted field studies for use in setting "interim" flows at Glen Canyon Dam to minimize the negative effects of dam releases on downstream natural and cultural resources in Grand Canyon National Park. Also, WRD staff was integral to studies designed to monitor and evaluate the effects of interim test flows on downstream resources in the park.

- WRD staff provided program and technical leadership to the federal community in the design of studies on the environmental, economic, and social impacts resulting from large-scale water development proposed by the Las Vegas Valley Water District in Nevada. The proposed diversions could impact Death Valley National Monument, Devil's Hole National Monument, Lake Mead National Recreation Area, and Great Basin National Park.

- WRD staff provided leadership for the NPS in the ongoing evaluation of the proposed Windy Craggy Project, an open pit copper mine located in extreme northwestern British Columbia, Canada, approximately 15 miles upstream of Glacier Bay National Park and Preserve on the Tatshenshini and Alsek Rivers. The NPS is very concerned about potential adverse impacts of the project on water quality, fishery resources, bald eagles, and wilderness and recreational values of the park. The Division's activities with respect to this matter have included the review of development plans for the project, consolidation of NPS comments, and close coordination with the park, Alaska Regional Office, other governmental entities, and the Department of the Interior's (DOI's) Office of Environmental Affairs.

- The new Watershed Protection Program came on line this year and has been implemented under two initiatives designed to distribute competitive funds for management oriented studies and to increase technical on-site assistance to parks. The first, Water Quality Management, is designed to augment the Service's ability to respond to and resolve critical water quality issues. The second initiative, Wetlands Management, is designed to broaden the awareness of wetland values and the importance of effective wetlands management and to support wetlands inventories, restoration, research, and protection efforts in parks.

- Geothermal development outside of Yellowstone National Park received the attention of the Secretary and the Congress this year. WRD staff assisted the park and the region in defending the report to Congress by the Geothermal Steam Act Admendments of 1988 and advocating the park's findings on whether nonfederal lands in the Corwin Springs Known Geothermal Resource Area (KGRA) should be acquired to protect park thermal resources. Also, WRD provided direct liaison for the park and region during the Department's formulation of its position on legislation designed to prohibit geothermal development outside the park.

- ❖ WRD staff identified the potential hazards of leachate from a landfill near Biscayne National Park. It was found that ammonia from the South Dade County landfill reached park waters in concentrations high enough to reduce reproduction and survival of aquatic animals. Information from field and laboratory studies was used by park personnel for negotiation of remedial actions by the county.

The Division expanded its outreach this year through increasing coordination with the WASO Operations Directorate. In cooperation with the Interpretation Division, we provided policy and program guidance to the Department's Wetlands Education and Outreach recommendations to the White House. We contacted the Ranger Activities Division and offered technical assistance in support of their post-fire watershed rehabilitation efforts. We enhanced program coordination with the Engineering and Safety Services Division by contributing to the Hazardous Materials program. We worked with the Denver Service Center (DSC) while revising our Floodplain Management guidelines and increased mutual awareness of conditions in each of our programs that influence Servicewide compliance with water resource laws, regulations, and policies.

To educate our users about the WRD, we are in the process of preparing a brochure on the work of the Division and how to access its products and services. Also, we completed our Strategic Plan which charts the path of the WRD over the next three years. In concert with the Natural Resources Directorate's 5-Year Plan, it will serve as a guide for the management and staff of the Division and provide standards for decision making as programs are developed and implemented. The plan includes a vision statement that leads to specified goals, objectives, and tasks that will help us achieve and maintain our vision.

WRD and its members are committed to quality and service. We are dedicated to the mission of the NPS and take pride in our responsiveness to the needs of individual parks and their Regions. Many of the entries that follow in this report highlight the support role that the Division plays in critical natural resource management decisions facing many units of the National Park System. While meeting the challenges of today, we continue to look toward future service. In the years to come, we will search out opportunities to contribute to our science, contribute, in any way we can, to the park resources that warrant our nurturance, and contribute to the cadre of dedicated professionals that serve the National Park System.

WASHINGTON LIAISON HIGHLIGHTS

by Pam Matthes
Program Coordinator

The WRD Liaison position, in its second year, expanded its realm of coordination to include not only intra-departmental working groups, but also memberships in water resources working groups outside of the DOI. WRD also continued its direct technical and policy assistance to the Directorate in highlighting, describing, and protecting the values of water resources in units of the National Park System. Examples of the contributions made in 1991 are provided below.

Intra-Departmental Work Groups:

Water Quality and Water Quantity Workgroup (WQWG) - This group discussed and established policy and legal positions on the Clean Water Act for the Administration. The WQWG prepared two of the six option papers for the Domestic Policy Council (DPC). The first, "Nonpoint Source Activities on Federal Lands" addressed how Federal land management agencies could improve federal leadership in preventing nonpoint source pollution. The second, "Protection of Riparian Areas" recommend ways in which federal and state land management agencies could preserve and restore riparian habitats. Although the option papers were completed in 1991, the Administration will not make a decision on which options to adopt until the Congress continues its hearings on the Clean Water Act in the Spring of 1992.

Wetlands Policy Working Group (WWG) - The WWG hosted a departmentwide symposium entitled "Wetlands Restoration on Federal Lands" last summer. The symposium provided a forum for Interior bureaus to highlight their work in wetlands restoration for a diverse audience, which included the environmental community, Congressional staff, key members of the news media, the general public, and other federal and state agencies. This group drafted departmentwide "Wetlands Enhancement Goals" that provide positive principles for wetlands management and several strategies for implementation that could be adopted by Interior bureaus.

Federal Interagency Committees:

California Drought Committee - This committee, composed of six subcommittees, was established by the DPC to coordinate federal actions during the drought. WRD represented the Service on the "Natural Resource Assessment" subcommittee and reported on the impacts sustained to park resources and visitors as a consequence of the drought, including updates on the potential for fires in units of the National Park System. This subcommittee was also asked to establish operational and budgetary priorities in order to maximize federal resources as a result of the California drought.

Coastal America Initiative - WRD expanded the list of participating agencies to include the NPS. The initiative represents a partnership among key Federal agencies and is designed to insure a comprehensive national strategy for stewardship of coastal living resources.

Interagency Wetlands Coordinating Body (IWCB) - WRD has represented the NPS on the IWCB since its inception in October 1989. This year the group published its "Directory of Federal Land Management Agency Wetlands Contacts" for wide distribution to interested federal and state wetlands managers. This is the first time wetlands contacts have been consolidated for the Federal community.

Federal/State Cooperation

Federal/State Wetlands Management Team - The Environmental Law Institute hosted two meetings of the federal and state Wetlands Management Agencies. The team is designed to encourage state and federal agencies to explore effective ways to coordinate research and management initiatives, primarily to encourage synergy that will benefit resources directly. WRD represented the NPS, both as a panel member and as a planning and coordination team member. As a result of these first meetings, several environmental groups are encouraging their memberships to provide increased volunteer assistance to federal land managers.

Direct Technical/Policy Assistance to the Directorate

Geothermal - This year the Division assisted Crater Lake and Yellowstone National Parks in departmental decisions on how to report hydrothermal study findings to the Congress. Technical assistance was provided to the department during Congressional enquiries and hearings regarding such reports.

Water Policy - In response to Congressional and environmental group enquiries, WRD assisted the Director in clarifying the current NPS Management Policies regarding water rights in units of the National Park System.

Everglades Lawsuit - WRD assisted Everglades National Park in securing the review and clearance of other Interior bureaus on the proposed settlement agreement with the South Florida Water Management District.

PLANNING AND EVALUATION BRANCH HIGHLIGHTS

by Dan Kimball
Branch Chief

The Planning & Evaluation Branch (PEB) of the WRD was involved in a number of major projects and technical assistance activities in support of park, Region, and Servicewide needs during 1991. Principal activities included assistance in the preparation of Water Resources Management Plans (WRMPs) and related scoping reports, the review of resource management plans, evaluation of complex regulatory issues, and implementation of the Wetlands Activity Component of WRD's Watershed Protection Program. Other PEB activities included technical review and advice and servicewide guidance and training. Some examples of these activities include involvement in the preparation of water resources management plans for nine units of the National Park System (see highlight articles following); assistance in the preparation of water resources management plan scoping reports for seven units; evaluation of a lead and zinc smelter and paper mill in British Columbia, Canada, upstream of Coulee Dam National Recreation Area; participation in a number of Great Lakes protection activities including the Great Lakes Commission's Groundwater Education Task Force, the Great Lakes Water Quality Initiative, and a Lake Superior Task Force which resulted in an historic agreement between the U.S. and Canada to implement a program to protect Lake Superior from degradation by toxic pollution, to use special designations to preserve waters of the highest quality, and to provide for broad-scale pollution prevention (see highlight article following); the evaluation and monitoring of wetlands protection projects; and providing Servicewide guidance, training, and technical assistance with respect to wetlands inventory, mapping, restoration, and regulatory requirements. The PEB also reviewed more than 325 documents (e.g., NPS planning documents [including over 60 resource management plans], National Environmental Policy Act [NEPA] documents, and proposed regulations). Written comments were prepared on over 25 percent of these documents. Another major activity of the PEB involved the development of a closer working relationship with the DSC to better integrate water resources concerns into the planning process (e.g., PEB participation in DSC planning activities at the Presidio of San Francisco in Golden Gate National Recreation Area, Sequoia National Park, Grand Canyon National Park, and Indiana Dunes National Lakeshore).

Development of Antidegradation Water Quality Criteria for Delaware Water Gap National Recreation Area

by Mark Flora
Hydrologist
and Joel Wagner
Hydrologist

Delaware Water Gap National Recreation Area (DEWA) includes a segment of the Delaware River and adjacent lands between Port Jervis, New York and Portland, Pennsylvania. This river reach was designated as part of the National Wild and Scenic River System in 1978, and is now known as the Middle Delaware Scenic and Recreational River (MDSRR). Among other features, visitors are drawn to DEWA to experience the high quality waters of the Delaware River for fishing, swimming, canoeing, and sightseeing. However, because of these same amenities, land development adjacent to the recreation area has increased dramatically through the 1980s, predominantly for vacation homes and year-round residences. Increased discharge from sewage treatment plants and increased nonpoint pollution from these expanding developments pose a threat to MDSRR water quality.

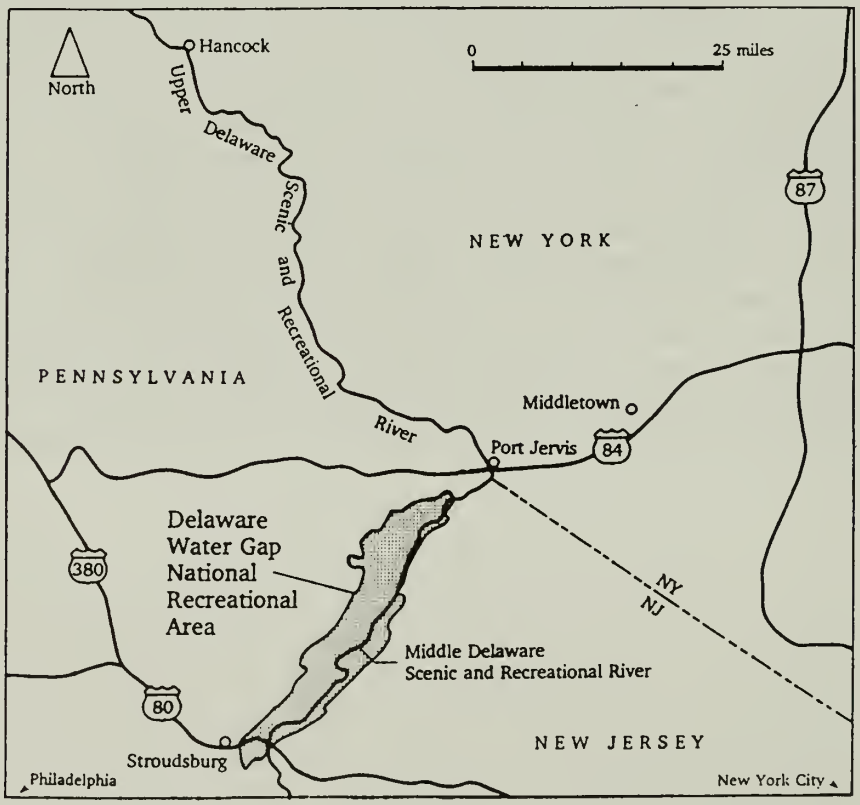
Water quality of the MDSRR and its major tributaries has been monitored in the past by the Delaware River Basin Commission (DRBC), the U.S. Geological Survey (USGS), the National Park Service, and the states of Pennsylvania, New York, and New Jersey. Preliminary analysis of data indicates that water quality in the MDSRR is generally better than that required by current state and DRBC standards, leaving the possibility for substantial degradation without actually violating those standards. To protect the MDSRR from such degradation, DEWA, DRBC, and the NPS WRD embarked on a multi-phase water resources planning process, including development of a WRMP for the Park. As part of this planning process, WRD and the Department of Statistics, Colorado State University (CSU), began developing a method for deriving a set of candidate water quality criteria for the MDSRR based on statistical analysis of historic (ambient) water quality data. The ultimate goal of this study was to provide a set of technically defensible water quality criteria that would reflect the current high quality of MDSRR waters and could be adopted by the DRBC to better protect the river from degradation.

For the joint WRD-CSU study, 34 water quality parameters were evaluated initially to determine which had potential for development of statistically-derived criteria. These preliminary analyses indicated that data sets for 12 of the parameters had sufficient "density" (number of observations over time) for statistical analysis and were free of significant "regime shifts" (sudden changes in the level or variability of the data), trends, seasonality, and other violations of basic statistical assumptions. A distribution-free (also called nonparametric) statistical method was developed and used to estimate 95 percent confidence intervals around the 85th, 90th, and 95th quantiles for each of these 12 parameters. These results have been presented to DRBC and are now being used in the process of strengthening water quality standards for the MDSRR.

A paper explaining the method and summarizing results of the analysis has been accepted for publication in the Water Resources Bulletin of the American Water Resources Association (Breidt, et al. 1991). We anticipate that the method will be useful for establishing antidegradation criteria for other NPS units where water quality substantially exceeds state standards and where sufficient data exist for this type of analysis.

Reference

Breidt, F.J., D.C. Boes, J.I. Wagner, and M.D. Flora. 1991. Antidegradation water quality criteria for the Delaware River: a distribution-free statistical approach. Water Resources Bulletin 27:4.



The Great Lakes Initiative: Special Designations to Protect Lake Superior

by Barbara West
Environmental Protection Specialist

The Clean Water Act gives the states the primary regulatory authority for managing and regulating the nation's water quality. Federal agencies, like the NPS, must comply with the requirements of state law for water quality management regardless of other jurisdictional status. As a consequence, finding the means to protect park resources requires working with states to obtain protection that safeguards water-dependent park resources and values.

Each state is required to have a three-tiered antidegradation policy to maintain and protect various levels of water quality and uses. The first tier requires that existing uses and the water quality necessary to maintain those uses be maintained. The second requires that where existing water quality exceeds fishable/swimmable levels then that level of water quality should be maintained. Limited water quality degradation may be permitted if it can be demonstrated that the fishable/swimmable uses will be maintained and important social and economic development will be supported by the water quality degradation.

The third tier of the antidegradation policy is designed to provide protection for waters for which ordinary use classifications are not sufficient. The U.S. Environmental Protection Agency's (EPA's) regulations that govern water quality standards state, "Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected." EPA has called this category "Outstanding National Resource Waters" or ONRW. For discharges proposed to ONRW, states often set effluent limits equal to the background levels of those substances upstream of the discharge. In other cases, new discharges to ONRW are prohibited entirely.

Unfortunately, as part of the state water quality standards development processes to date, the waters of Lake Superior have not been designated as ONRW by any of the

three states that border Lake Superior. The Great Lakes Water Quality Initiative, mandated by the Great Lakes Critical Programs Act of 1990, includes representatives of all of the Governors of the Great Lakes states and EPA. Its purpose is to develop new water quality standards for the Great Lakes states that are consistent and provide additional protection for the resources and values of the Great Lakes.

The NPS has participated in the Great Lakes Water Quality Initiative with the states and EPA to obtain ONRW designation for Lake Superior. As part of that process, NPS was appointed to the Lake Superior Task Force, a group composed of Federal officials from the U.S. and Canada, the Province of Ontario and the states of Minnesota, Michigan, and Wisconsin. The Task Force negotiated an historic agreement that was announced at the Biennial meeting of the International Joint Commission in Traverse City, Michigan, in early October 1991. Under that agreement, the Governors have committed to initiate state procedures to designate special areas -- including national parks and lakeshores -- as ONRW through the Great Lakes Water Quality Initiative and to designate all the waters of Lake Superior as Outstanding International Resource Waters (OIRW). These designations would prohibit the discharge of certain bioaccumulating, persistent toxics to Lake Superior and its watershed. The agreement also stated that EPA and the states would evaluate the possibility of pursuing and supporting other special designations for the Lake Superior basin including Biosphere Reserve status and International World Heritage Site designation. NPS participation in the Initiative and the Task Force focused attention on the need to protect the parks that are in or border on Lake Superior -- Apostle Islands and Pictured Rocks National Lakeshores, Isle Royale National Park, and Grand Portage National Monument. ONRW and OIRW designation will provide long-term protection for the quality of Lake Superior park waters and provides a model for state-federal cooperation.

Water Resource Management Planning at Organ Pipe Cactus National Monument

by David Sharrow
Hydrologist

Water resources management planning in one of the most arid NPS units appears to be a contradiction. True, this is one of the driest places in North America, averaging about 8 inches of precipitation a year, and the number of perennial natural water sources can literally be counted on one hand, however, this very scarcity makes the water resources of Organ Pipe Cactus National Monument (ORPI) extremely valuable. Combine this with an immediate threat from ground water pumping adjacent to the monument in Mexico, and the need to focus on water resources becomes clear.

The need for a WRMP for ORPI was first identified in 1983. However, little progress was made until 1989, when the WRD began a project to write a WRMP with the assistance of the ORPI's Resources Management staff. The plan was completed in 1991. A WRMP was needed at ORPI because water resources threats were imminent and associated impacts could be irreversible. In addition, although several studies and monitoring programs had been conducted, there had been no synthesis of the information. Furthermore, although the need for further studies had been identified, specific study objectives and actions had not been determined. As such, a WRMP was needed for ORPI to support NPS's decision-making process related to the protection, conservation, use, and management of the monument's water resources and to serve as the basis for the development of a water resources program for the monument.

In particular, the WRMP addressed the protection of Quitobaquito Springs, located near the southern boundary of the monument. This reliable, flowing spring has been a center of activity from prehistoric times. It was first mentioned by Europeans in 1698 and became a vital watering stop on the "Camino del Diablo" or Devil's Highway, an early southern route to California and the Colorado River. In more recent times, the ecological importance of the water and oasis at Quitobaquito has been recognized. It provides habitat for several species, including the endangered Desert Pupfish (*Cyprinodon macularius*) and Sonoran Mud Turtle (*Kinosternon sonoriense*).

Beyond Quitobaquito Springs, the WRMP also addressed two perennial springs, a few other intermittent springs, and 58 tinajas (rock catchments) that hold water for weeks or months following significant rainfall. All of these are critical water supplies for plants and wildlife, few of which can survive indefinitely without water. Ranchers, NPS, U.S. Customs and Immigration, and other property owners have drilled or dug 51 wells in the monument. Of these, 21 are currently dry, abandoned, or have caved-in.

Threats to park waters originate almost entirely in Mexico. Irrigated agriculture is flourishing there where 32,000 acres have been developed, supported by 290 wells pumping over 55,000 acre-feet of water annually. The Mexican government recognizes ground water overdraft as a problem and has placed a moratorium on new wells, but water is still being withdrawn at approximately 2.5 times the rate of recharge. Three monitoring wells were drilled along the border in 1988 where water levels are continuously recorded. An additional 14 wells are monitored regularly by monument staff and/or the U.S. Geological Survey (USGS). The flow of Quitobaquito Springs has been monitored since 1974, however, seasonal and yearly variations in flow and problems with the spring's channel have hampered any identification of long-term trends.

With respect to potential adverse impacts to the monument resulting from continued lowering of the ground water table in Mexico, the WRMP concludes that:

- the flow of Quitobaquito could be diminished or lost;
- land subsidence is expected first along the border,with subsequent extension northward, and possible development of earth fissures around the edges of Sonoyta Valley and permanent loss of aquifer capacity;
- ORPI's water supply wells could go dry; and
- riparian vegetation could be lost.

The WRMP contains 19 project statements which address the concerns identified above and also issues related to water rights, inventory and monitoring of water resources, water conservation, control of accelerated erosion, contamination from abandoned mines, flood hazards, incorporating water resources in GIS, and monitoring precipitation chemistry and wastewater systems.

WATER RIGHTS BRANCH HIGHLIGHTS

by Owen Williams
Branch Chief

The real and present danger to park resources from out-of-park water development continued to grow in 1991. The Water Rights Branch (WRB) faced increasing challenge in terms of both workload and the technical complexity of its activities. As a result, the NPS was a central player in several water rights-related activities in 1991. For example, the potential effects from American Water Development, Inc.'s planned ground water pumping in Colorado's San Luis Valley to the Great Sand Dunes National Monument have been central to the litigation which will determine if the project can go forward.

Similarly, because of concerns about the effects on water-related resources at Death Valley National Monument, Lake Mead National Recreation Area, and Great Basin National Park, the WRB has taken the technical lead role in organizing and completing studies to produce data and testimony to be used by four Department of the Interior Bureaus. These data and testimony will support, in hearings before the Nevada State Engineer in September 1992, the bureau protests of applications by Las Vegas Valley Water District to appropriate massive amounts of ground water.

The NPS activities to protect its water rights and, through them, its resources from the impacts potentially consequent to out-of-park water development have been numerous and scattered. To "cover the waterfront" with limited staff and financial resources, the WRB has had to increase its efficiency. In the articles which follow you will read about the manner by which the WRB has used advanced technology to increase the productivity of its staff. You will also see that by increasing productivity, more has been accomplished in the way of resource protection.

Not only has the WRB utilized new technology to protect NPS resources, it has also looked to new areas of science. You will read of WRB-supported studies of hyporheic habitat and the biota which occupy it, an exciting and promising new area of biologic investigation with important water rights/resource protection implications.

Of course, the routine activities necessary for protecting water rights must be handled and will always be with us. But even in the mundane the WRB is making advances. You will read in the following of the progress made in 1991 to accomplish WRB's plan to protect the NPS's water rights dockets and to efficiently make information available to parks and Regions.

All in all, 1991 has been a time of challenge and continued transition for the WRB. The pace of water development and court activity continues to increase, and there is little likelihood that this trend will change any time soon. We, in the NPS, must remain vigilant to the potential injuries to NPS resources which may attend out-of-park water development. The Service's commitment to water rights protection has thus far been justified and, in my view, can only be more so in the future.

Use of Advanced Technologies to Improve Field Methods

by Jeff Hughes
Hydrologist
and Jeff Albright
Hydrologist

Projects undertaken by the WRB often require site visits to obtain technical information concerning water-related resource attributes in national parks. In some cases, extensive and complex data collection activities are required. The ability to collect field data in a timely and cost-effective manner is therefore important.

Two technologies recently acquired by the WRB demonstrate that advanced electronic instrumentation can reduce time spent in the field and/or improve accuracy of data collection over previously used methods. These instruments, which collect topographic survey data, demonstrate the benefits offered by use of advanced technology. One instrument, a hand-held Global Positioning System (GPS), determines ground locations (latitude and longitude) based on signals received from satellites.

The GPS unit allows one person to quickly traverse a study area by car or foot and measure the location of water-right related features in parks. GPS was recently used to plot the position of ditches and irrigated fields at Grand Teton National Park. The surveying tasks required approximately one day of field time. Conventional surveying methods would have required two people and two or more days of field time. Some of the conventional methods would have been more accurate, but GPS technology provided the appropriate level of accuracy for the purposes in this case, and at substantially reduced costs.

Some anticipated applications should result in even greater reduction of staff time. For example, mapping wells in remote locations would be greatly facilitated by use of a GPS unit. Another benefit is that the GPS unit requires less time for operator training in comparison to conventional surveying equipment. The GPS unit also provides an instant readout of calculated ground locations, which allows more rapid plotting and error-checking of data in the field than is possible with other surveying methods.

Some surveying tasks are more complex, and require more accuracy than provided by GPS. For example, detailed topographic data are required for many of the hydrologic models used by the WRB. The WRB recently acquired another survey instrument called a Total Station (TS), which is an electronic theodolite with a distance measuring device attached. The TS can measure vertical and horizontal angles and distance to a point. When the data collector is connected, all angles and distances are calculated and stored automatically, eliminating the need for manual calculations in the field. This saves time and reduces possible errors associated with entering data.

The TS allows data points to be surveyed from great distance (points in excess of 2,500 feet from the instrument have been measured). Also, the TS can operate even with small amounts of vegetation in the instrument's line of sight. Each of these capabilities result in reducing the number of instrument setups, thereby saving time.

The WRB has used the TS at Black Canyon of the Gunnison National Monument, Glacier National Park, and Mesa Verde National Park, to gather data to support water right claims. Field crew leaders estimate that they have saved more than 3 months in field time over a period of 1.5 years by using the TS instead of a surveyor's level. When this time savings is converted into dollars, the TS system has already recouped its purchase price.

The use of these technologies has facilitated data collection, interpretation, and error-checking. Significantly, the accuracy of data obtained through these methods is as good as, and often better than, information obtained using previous methods. Equipment acquisition and training costs can offset some of these advantages, but long-term benefits outweigh initial expenditures.

Investigation of Hyporheic Habitats in Glacier National Park

by William R. Hansen
Hydrologist

Water resource development projects have impacts on natural resource values both within and near National parks. The NPS is currently using a decision assessment methodology called Departure Analysis to assess complex responses of water-related resource attributes on surface and ground water regimes (Ponce and Williams 1989). Because most large rivers have extensive floodplain aquifers which are hydrologically connected to the channel, it is important to evaluate the impacts of altered flow regimes on river ecology.

Instream flow studies have historically focused on the physical habitat of fisheries and recreational values of flow and not on the ecological health of the river. Recent research conducted in the Flathead River, Montana, by Stanford and Ward (1988) and Ward and Stanford (1989) indicates that biodiversity in gravel-bed rivers is in large measure related to the existence of hypogean food webs. The ground water zone penetrated by amphibiotic organisms is referred to as hyporheic habitat and the biota present are the hyporheos (Stanford and Ellis 1990).

The hyporheic zone is defined as an ecotone or transition between the surficial stream bed and the true ground water habitat. Many of the hyporheos recently found in gravel-bed rivers are new to science and may be very sensitive to environmental changes wrought by man (Ward and Stanford 1989). Ward and Stanford found that ground water fauna (hyporheos) consist of two major elements: (1) members of the stream benthos that temporarily move some distance into the streambed substrate (amphibiont); and (2) specialized ground water forms that rarely, if ever, occur in the surficial stream bed (stygobiont).

Hyporheic zones can be extensive. The hyporheic zone on the Flathead River in Montana averages 3 km wide and 10 m deep; whereas, the channel (median flow) is about 50 m wide (Stanford and Ward 1988). Stanford and Ward estimate that there was about 0.3 km^3 of hyporheic habitat compared to 125,000m^3 of channel habitat (within their study area) and that standing crop biomass could easily exceed benthic biomass.

The hyporheic zone serves as a refuge for the surface benthos, offering shelter from floods, drought, and temperature extremes, and providing suitable and predictable conditions for immobile stages such as eggs, pupae, and diapausing larvae. The hyporheic zone also offers protection from large predators and contains a faunal reserve capable of recolonizing surface benthos, should they be depleted by adverse conditions (Ward and Stanford 1989).

Because hyporheic habitat is important to the ecological health of rivers, the WRD has initiated a cooperative study in Glacier National Park (GLAC) with the Flathead Lake Biological Station, University of Montana (FLBS), to determine the relationship between flow maintenance in hyporheic habitats and biota. The objectives of the study are to determine the extent (volume) of hyporheic habitat on the Nyack floodplain of the Middle Fork of the Flathead River as a function of river discharge, to determine if the hyporheos of the Nyack floodplain changes in relation to the volume of habitat available, and the generality of inferences derived from study of the Nyack floodplain to other stream segments in GLAC.

To do this, the WRD and the FLBS have drilled a network of wells and have installed electronic data loggers to measure water level and stream discharge in the Nyack Flats area and the tributaries of Nyack and Harrison Creeks. Continuous discharge and static water level measurements are made to determine the correlation between river flow and ground water levels. Discharge will be used to evaluate the input and output of water through the Nyack floodplain. In addition, the FLBS is collecting large invertebrates (hyporheic insects) in the Nyack floodplain to determine the presence and diversity of hyporheos.

By using such an ecological approach, it is hoped that the NPS can determine the importance and extent of hyporheic habitats in GLAC and develop an assessment technique which can be used to determine instream flow needs in National parks.

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The National Park Service's Water-Right Docket System

by Paul K. Christensen
Hydrologist

In 1991, the WRD appraised, updated, and reorganized the water-right dockets maintained by WRD in Fort Collins, Colorado. The dockets are files which contain documents pertaining to water rights held by the NPS. Additionally, a finding aid was developed in DBASE III+ format, containing basic information on each water right. RM Resources of Denver, Colorado, was contracted to perform much of the work.

The former docket system was reorganized so that information pertaining to each water right is located in a single folder divided into six sections containing state water-right documentation, land history, legal opinions, administrative agreements, supporting hydraulic data, and other supporting documentation. Pertinent documents from files previously maintained in the Washington Office and not in the former docket system were incorporated into the dockets. Each docket has a number which consists of the park's code and a four-digit number (e.g., DEVA-0004).

The docket appraisal found many documents not directly related to water rights or relating to non-NPS water rights. Many of these documents, which include reports on water-resource studies, water supplies, water-distribution systems, and water rights in general, will be incorporated, as appropriate, into the WRD reference library or other files.

The finding aid will provide easy access by NPS employees to each water right so employees can quickly locate basic information. The finding aid can display on the screen items pertaining to each water right, for example, priority date, source of water, place of diversion, place of use, diversion rate, and license or certificate numbers. Short DBASE III+ programs can be written to sort through the water-right information and tabulate items of specific interest.

According to RM Resources, there are about 85,000 pages and maps in the docket system. Many of these are very old and are beginning to physically deteriorate, making them difficult to read. RM Resources provided recommendations on microfilming and

storing the dockets so that microfiche copies are available for daily use, while the often delicate originals can be securely preserved. WRD plans to begin microfiching the dockets in 1992. After the microfiching has been completed, the original docket materials can be moved to a climate-controlled storage facility. Parks will be sent microfiche copies of their water-right dockets and the accompanying finding aid in DBASE III+ format. At that time, the content of park dockets can be compared to that of WRD dockets to identify additional records in need of long-term protection.

WATER OPERATIONS BRANCH HIGHLIGHTS

by William L. Jackson
Branch Chief

This was a year of substantial accomplishment for all five of the Water Operations Branch's (WOB) activity areas. The Surface Water Hydrology/Floodplain Management activity completed a draft proposed revision of the NPS Floodplain Management Guidelines. In addition, the Branch has become proficient in conducting flood hydraulic modeling and floodplain mapping using recently acquired AutoCad software. This has greatly enhanced the Branch's ability to conduct floodplain assessments. In an article which follows, Gary Smillie describes how hydraulic modeling was applied to the analysis of a proposal to reconstruct the terminal moraine at El Capitan Meadow in Yosemite National Park.

In addition to its long-standing proficiency in well siting and water table elevation monitoring, the Ground Water Protection and Development activity greatly enhanced its capabilities in the area of ground water modeling. In an article which follows, Larry Martin describes the application of ground water modeling to assess the potential impacts of ground water pumping near Cape Hattaras National Seashore on wetlands within the park. It is hoped, in 1992, to further enhance the analysis of ground water impacts on the park resources by integrating ground water models with park GIS systems.

The Branch's water quality activity successfully implemented the first year of the water quality component of the Division's Watershed Protection Program. Fourteen park-based water quality projects were funded. Additionally, a personal computer-based water quality data management program is being developed for park use, and a cooperative agreement was established with Colorado State University to assist in developing water quality monitoring technical guidance. Staff capability in water quality was enhanced by the addition of two technical specialists; a physical-chemical water quality hydrologist and an aquatic biologist (bio-monitoring).

The Watershed and Stream Management activity provided technical assistance on a variety of stream erosion and riparian rehabilitation issues. Additionally, that activity

is working with the Data Management/GIS activity to develop enhanced watershed modeling (runoff and erosion) capability in a GIS environment. A cooperative agreement was established at Colorado State University to assist the Southeast Region in modeling erosion impacts resulting from land development adjacent to Virgin Islands National Park. Finally, in an article by Rick Inglis, you will read about a project to investigate beach erosion caused by rapidly fluctuating daily flows in the Colorado River, Grand Canyon National Park.

The Data Management/GIS activity obtained funding from the NPS Inventory and Monitoring Program to develop improved systems for water quality data management and to develop prototype water resources modeling projects in GIS environment. A cooperative agreement was established with Colorado State University to assist in this program. Additionally, the necessary computer hardware and software to operate the NPS-GRASS (Geographic Resources Analysis and Support System) GIS system was acquired.

In addition to some of the major accomplishments described above, the Branch maintained a large technical assistance workload, completing over 80 technical assistance efforts in all ten NPS Regions. Finally, the Branch designed and facilitated a 1-week training session on Water Resources for the Natural Resources Management Trainee Program.

Simulation of the Effects of Restoration of El Capitan Moraine Yosemite National Park

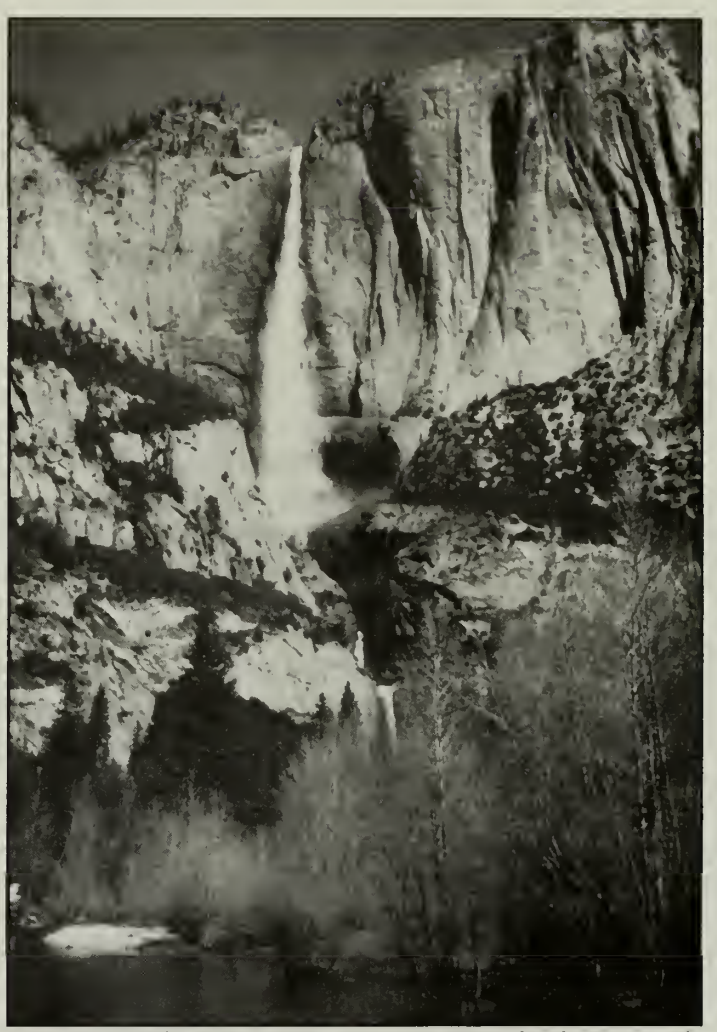
by Gary M. Smillie
Hydrologist
and Mike Martin
CSU Graduate Student

The WOB recently conducted an investigation of the effects of restoring the historic elevation of El Capitan Moraine in Yosemite National Park. The moraine serves as a hydraulic control for the Merced River in the central chamber of Yosemite Valley. This means that the relatively non-erodable moraine establishes an elevation below which the finer-grained sediments of the central chamber cannot be eroded. In the early 1900s, the moraine was blasted and reduced in elevation by approximately 4.5 feet to decrease flooding in the valley. This change in base level resulted in headward incision of the channel and may have caused, among other effects, a general lowering of ground water.

In recent years the park has become interested in the possibility of restoring the historic elevation of the moraine in an attempt to recreate preexisting conditions.
To evaluate the potential for achieving this objective, this study simulated the effects of the restoration of the moraine by modifying contemporary cross-sectional profiles to account for the sediment wedge that would deposit upstream of the moraine as a result of the increase in base level. The amount and extent of sediment deposition in the channel was estimated by applying a relationship derived from published observations of sedimentation behind small dams. Cross-section survey information was obtained from a U.S. Army Corps of Engineers (COE) flood study, and a computer hydraulics model, HEC-2, was used to simulate river response to the proposed reconstructed moraine.

The results of the study indicate that channel aggradation would occur from the moraine upstream to about Yosemite Lodge, a distance of approximately 20,600 feet. Unlike the natural, nearly flat lacusterine sediments that were eroded after the moraine was lowered, the thickness of the new deposits would diminish rapidly from a

maximum of about 4.5 feet at the moraine to zero near the lodge. As a result of this differential sedimentation, frequency of flooding along the river would be affected in different amounts at different locations. For example, out-of-bank flooding near the moraine would occur, on-average, about 1 year in 200 with the present channel and about 1 year in 100 with the proposed channel modification. Out-of-bank flows occur roughly every 1.5 years on average near Yosemite Lodge . The channel capacities here were likely unaffected by earlier down-cutting and would be unaffected by deposition caused by moraine reconstruction. The effect on ground water would, likewise, be a function of distance from the moraine. Assuming an unconfined alluvial aquifer exists in the central chamber of Yosemite Valley, ground water levels may become elevated from present levels, but by no more than the change in local channel elevation.



Yosemite Falls with the Merced River in the foreground. (Photos by W.L. Jackson)

This study is an example of how traditional flood modeling can be used to address other problems related to river management. Units of the NPS are confronted with a wide array of water resources related problems and issues. The WOB is available to play an important role in providing information to managers charged with the responsibility of making sound decisions in a technical arena often outside of their personal expertise.

PHOTOGRAPHS OF THE EL CAPITAN MORAINE AREA
Yosemite National Park

Merced River in the vicinity of El Capitan Moraine.

A meander of the Merced River in Yosemite Valley.

Beach Erosion Study During Fluctuations of the Colorado River Grand Canyon National Park

by Richard Inglis
Hydrologist
and William Werrell
Hydrologist

Study beach at low river stage. (Photo by W. Werrell)

An investigation of beach erosion caused by ground water seepage was conducted by the WRD in support of the Glen Canyon Environmental Studies (GCES) Program. The GCES Program, funded by the Bureau of Reclamation, is evaluating the effects of daily water release patterns from Glen Canyon Dam on downstream resources in Glen

Canyon National Recreation Area and Grand Canyon National Park. Until August 1, 1991, flows were released from Glen Canyon Dam in response to electric energy demand, and fluctuated by as much as 26,000 cubic feet per second (cfs) daily. Since August 1, 1991, interim operating constraints have restricted daily fluctuations to no greater than 8,000 cfs. Information from the GCES Program will be used in preparation of an Environmental Impact Statement (EIS) on the effects of alternative dam operations on downstream resources. Interim flow criteria will remain in place until a record of decision on dam operations, stemming from the EIS, is made by the Secretary of the Interior.

The WRD investigation is focused on evaluating effects of shallow ground water seepage on erosion of beach faces located along the margins of the Colorado River. Ground water movement is the result of recharge and discharge (seepage) from the river banks during alternating high and low water levels in the river. The study was conducted during two periods under different release regimes from the dam. During the first period, dam releases ranged from about 3,500 to 15,000 cfs, resulting in water level fluctuations of about 243. 8 meters (m) (8 feet). During the second period releases from the dam ranged from about 10,000 to 18,000 cfs and water level fluctuated about 1.2 m.

River stage and ground water elevations were monitored continuously during each period. Precise daily measurements of beach face elevations were recorded at transects between high and low water levels. Elevation data were collected by an instrument designed and built by WRD which provides topographic data at 58 points over a distance of 457 m (15 feet). In addition, an experiment was conducted with drain pipes set into the beach face to induce ground water drainage. Photographic and video documentation was acquired during both periods to further demonstrate the role of ground water seepage on beach erosion.

Video analysis indicates beach face erosion occurs during periods when the river level falls below the ground water table within the beach. Ground water discharges from the beach face as a seep or spring line at low river levels. As the water flows down the beach face to the river's edge, it scours loose sand from the beach and forms small migrating channels. Daily repetition of this process creates a cumulative loss of beach. Erosion rates of 2 to 12 millimeters (mm) were documented for the first period of 7 days. Beach accumulation ranging from 3 to 6 mm occurred in the second period of 18 days. Beach aggradation was attributed to sand trapped in near-shore eddy flow,

depositing at a slightly higher rate than it is eroded by beach face seepage. Generally, as the amount of river fluctuation increases, beach erosion due to ground water seepage increases.

The results of this study contributed to the development of the interim flow prescription implemented on August 1, 1991. They also will be used in the preparation of the EIS to evaluate the effects of alternative flow regimes on downstream resources.

PHOTOGRAPHS OF THE BEACH FACE EROSION STUDIES
Grand Canyon National Park

Ground elevation differential gauge on a transect measuring erosion caused by ground water seepage. (Photo by R.I. Inglis)

Perforated drain pipes placed in a test plot, capture and convey ground water thereby, virtually eliminating seepage-induced beach erosion.
(Photo by W. Werrell)

Conflicting Water Management Objectives in the Cape Hatteras Area

by Larry Martin
Hydrologist

Land ownership in the Cape Hatteras area of North Carolina is split between private and Federal ownership. The NPS has jurisdiction of the south half of the island; most of the north half of the island is privately owned and subject to residential development. Despite this rather clean split in land ownership, and therefore land uses, the island is dependent on a single common source of ground water for potable supplies. Perturbations to the hydrologic system on any part of the island may show up as impacts on another part of the island. The NPS is concerned that increased ground water withdrawals for private development may cause water table declines resulting in dewatering of wetlands and lowering of the ground water table in maritime forests within Cape Hatteras National Seashore.

Because the Cape Hatteras area is a barrier island, ecosystems are dependent on maintenance of the hydrologic balance between recharge and discharge of the freshwater aquifer. Excessive ground water withdrawals may change the position of the freshwater-seawater interface, allowing salt water to intrude into parts of the freshwater aquifer. Another concern is maintaining the water table at the elevations that would occur without pumping by private water users. Water table declines could stress wetland vegetation and alter natural vegetation communities on NPS lands. Water levels in some of these wetlands drop below the land surface during extended dry periods. Increased ground water withdrawals may increase the frequency, duration, and extent of temporary drying of these wetlands.

There is a lack of detailed hydrogeologic knowledge for the area, although general information is available (e.g., aquifer thickness and hydraulic conductivity estimates). Other hydrologic variables (e.g., recharge rate, annual/seasonal water table variation, water table elevation, and discharge to the ocean) have, only been estimated. There has been very little monitoring to document impacts on the water table elevation from existing wells or to monitor naturally occurring seasonal or annual hydrologic variation. Therefore, it is very difficult to accurately define the impacts from the existing well field or to predict impacts from proposed new well fields.

A computer model of the ground water flow system on Hatteras Island was utilized by the WRD to allow rapid assessment of impacts for a wide range of hydrologic conditions. Because the modeling work is based on limited field data, multiple model simulations were made to assess the sensitivity of the model to variations in hydraulic conductivity, storage coefficient, and recharge rates. Preliminary computer modeling of the ground water flow system indicates that the proposed well field may lower the water table between 2 and 4 feet in the immediate vicinity of the well field. Estimates of the area of potential impact (greater than 1 foot of water table drawdown) range from about 3,000 to 5,000 feet from the proposed well field.

This information can be used by ecologists and botanists to predict vegetative response to hydrologic changes caused by ground water withdrawals at the proposed well field. Field studies begun by North Carolina State University in October 1991, will provide additional data to verify and refine the model. Additionally, the WRD is working with the Southeast Region to evaluate opportunities to enhance the ground water modeling effort at Cape Hatteras National Seashore by interfacing those efforts with the park's geographic information system.

APPLIED RESEARCH BRANCH HIGHLIGHTS

by Gerald E. Walsh
Branch Chief

In 1991, the Applied Research Branch (ARB) of the WRD conducted research in parks in the following scientific areas: water allocation, watershed studies, population and community analysis of macroinvertebrates and fishes, water quality, risk analysis, and multiple use analysis of park waters. Research was designed to address needs of NPS Managers by analysis of park-specific and Servicewide problems and by scientific studies that aid in protection, regulation, and use of water resources. Data from such studies were used to predict effects of environmental changes within and outside of parks that affect sustainability of park ecosystems.

Specifically, ARB personnel investigated problems in 18 parks in 7 regions. Long-term research was continued on biogeochemical cycling of ions in lakes and rivers, effects of climatic change, precipitation and terrestrial events on water balance within watersheds, acquisition of baseline data on hydrologic patterns and chemical flux in watersheds, stream ecosystem analysis in relation to use of watersheds, effects of non-point sources of pollution from outside park boundaries on park waters, and structure of aquatic communities in relation to water diversion practices. ARB personnel also conducted formal courses on application of their research findings to park problems.

The descriptions of research projects that follow give only a limited idea of the capabilities of the ARB. The scientists of the Branch are experienced in many areas, including hydrology, systems analysis, resolution of conflicting demands for use of water resources, algal, plant, and animal toxicological studies in the laboratory and field, and impact assessment.

Baseline Watershed Studies

by Robert Stottlemyer
Research Ecologist

Long-term study of the effects of anthropic atmospheric deposition on lake/watershed ecosystems of Isle Royale National Park (ISRO) and Biosphere Reserve, and Pictured Rocks National Lakeshore (PIRO): This research was initiated in 1981 as part of the National Acid Precipitation Assessment Program (NAPAP) following a park- and Region-wide assessment of surface water quality in both lakes and streams. This research has involved Wallace Lake, ISRO; Calumet Experimental Watershed, Keweenaw Peninsula, Michigan; and the Legion Lake watershed, PIRO. Recently, the ISRO watershed sites were selected for additional study on possible effects due to global change.

Why use the watershed ecosystem as a research/monitoring tool? There is an increasing body of scientific literature which suggests that the ecosystem approach gives us both an early assessment of incipient change due to natural or anthropic-induced stress, and an accurate quantification of the magnitude of change. In addition, use of the ecosystem as a research/monitoring tool provides a much improved context within which to formulate and test specific hypotheses. Unlike aquatic ecosystems where components, such as phytoplankton, provide the most sensitive indicator of change, processes in terrestrial ecosystems (production, decomposition, nutrient cycling) are the most sensitive to change as a result of stress. Essential baseline information for assessing the impacts of stress in terrestrial ecosystems includes quantification of nutrient and energy pools and the rate of transfer between these pools. A typical approach to obtain such data is illustrated by our past study on ISRO.

Replicate permanent plots within each major vegetation type of the watershed were instrumented to measure canopy throughfall, litter, and soil water chemical change prior to entering the stream or lake. Biomass, its chemistry and decomposition rates, were quantified to estimate rates of nutrient cycling within each major vegetation type. These studies have been conducted in instrumented watersheds (meteorological station with National Atmospheric Deposition Program (NADP) collection protocol, gauged stream outflow) which, with the plot data, permit quantifying the major mechanisms

responsible for variation in input/output chemical budgets. The conceptual approach was altered to meet the requirements of this region with its long winter and heavy snow input. The PIRO research focused primarily on a very sensitive, clearwater seepage lake of low pH.

At ISRO and PIRO, much of these baseline data have been amassed, and the current emphasis is on addressing the following hypotheses: (1) boreal forest soils, due to their high organic matter content, moderate pH, poor weathering, and abundance of conifers, are more sensitive to cation nutrient leaching by SO_4^{2-} than northern hardwood soils; (2) watershed/lake ecosystems with perennial surface streams retain virtually all H^+ and NO^{3-} inputs in the terrestrial component, but SO_4^{2-} input passes through the terrestrial component into the aquatic system; and (3) sensitive clear water seepage lakes are the result primarily of edaphic factors and incipient stages of natural acidification attributable to vegetation/lake succession.

Effect of climate change on hydrology, production, decomposition, and C:N pools in fringe boreal watershed ecosystems: This study focuses on the Wallace Lake watershed/lake ecosystem, ISRO, and is being conducted in cooperation with Drs. L. Ohmann, Project Leader, U.S. Forest Service North Central Forest Experiment Station, St. Paul, Minnesota, and
R. Phipps, Botanist, U.S. Geological Survey, Urbana, Illinois. The background for this research, which has just begun, is as follows.

Global climate scenarios for this region fail to take into account present atmospheric contaminant inputs of nitrogen ($N > 6$ kg ha^{-1} yr^{-1}), a level which exceeds the ecological requirements of major boreal forest species. Half this input is high energy NH^{4+} possibly preferred by boreal conifers. It has been thought that much of this N would be unavailable to forest species, but boreal watershed-level studies show strong N retention. N inputs could accentuate the effect of elevated CO_2 and alter species' capacity to accommodate climate change. Ecosystem N availability is also dependent upon forest floor and soil organic matter (SOM) amounts and quality (C:N ratio), which are species dependent. Forest soil C:N ratios are good indices of ecosystem productivity and, along with soil moisture, account for much of the variation in organic mineralization rates. In addition, the net effect of increased CO_2, temperature, and change in moisture will depend upon the vegetation type. It is anticipated that species response will best be explained by their respective maintenance requirements, carbon fixation rates, and N mineralization primarily in soils.

Determination of natural and anthropic factors responsible for long-term variation in streamwater chemistry and input-output balances, alpine and subalpine forested watersheds, Fraser Experimental Forest, Colorado: This study is being done in cooperation with the U.S. Forest Service Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado, with Dr. C. A. Troendle, Project Leader and Principal Hydrologist, my co-investigator.

The long-term research goal is to quantify nutrient and energy pools in subalpine and alpine watershed ecosystems of the Rocky Mountains, determine transfer rates among these pools, and assess their sensitivity to episodic anthropic stress such as direct land manipulation, and chronic stresses such as global change and atmospheric contaminant inputs. The study has been underway since 1982, and includes the Deadhorse, Lexen, Fool Creek, and East St. Louis watersheds, Fraser Experimental Forest, Fraser, Colorado. Basic hydrologic and meteorologic data gathering began on the E. St. Louis watershed in 1937, and in the others between 1947 and 1956. The present research objectives are as follows: (1) quantify and contrast nutrient cycling rates in a subalpine and alpine ecosystem using the watershed as the experimental tool; (2) quantify the effect of elevation and canopy loss on the loading of atmospheric inputs, and the ecosystem response to these inputs; (3) assess the sensitivity of stream chemistry change in detecting change in terrestrial processes; (4) quantify the magnitude and significance of snowpack ion loading in terrestrial ecosystem processes and on watershed input/output budgets, and 5) provide for the long-term ecosystem-level monitoring of atmospheric inputs, watershed outputs, and the importance of ecosystem stress on nutrient cycling. This project provides a large and long-term data base for development of tools to detect the sources of variation in stream water chemistry for assessing change in the National Parks.

Geomorphological and biological regulation of surface water chemistry, Noatak National Park and Preserve. This study, initiated in 1989, is another in a series of studies in Alaskan national parks and preserves in which we have characterized the surface water chemistry to provide a baseline against which possible future change may be assessed.

The conceptual approach is as follows. First, we assess the surface water quality over a large number of first- and second-order watersheds varying in geomorphology and vegetation type. Using nonparametric analyses, we attempt to relate regional surface water quality to these factors. Second, we follow up this extensive study with an

evaluation of seasonal change in surface water using a sub-set of the watersheds previously examined. Finally, we focus on one to three watersheds to obtain some idea of the effects of stress on terrestrial processes and the sensitivity of surface water chemistry in detecting these changes.

The current phase of this study focuses on a few watersheds along the Agashashok River east of Asik Mountain, and is being done in cooperation with Dr. Dan Binkley, Colorado State University. This site was selected because it is in the middle of the transition zone between boreal forest and tundra and is accessible by fixed wing aircraft. The present study includes 1) examination of seasonal change in the quality and quantity of surface water, 2) quantification of the apparent advancement of white spruce into the tundra, and 3) assessment of the potential effects of change in soil moisture and temperature on the nitrogen cycle in white spruce which occurs here at the very northern end of its range. Results from these studies will be interpreted in the context of detectability of change in such terrestrial processes by monitoring surface water quality. If such is the case, this provides us with an additional tool to extrapolate rather site-specific results from a few watersheds to larger geographical regions.

Biogeochemical Cycling/Aquatic Ecosystem Ecology of Rocky Mountain National Park

by Jill Baron
Research Ecologist

Continuous monitoring since 1982 of atmospheric and aquatic parameters of Rocky Mountain National Park (ROMO) has been coupled with biogeochemical research to increase understanding of the processes controlling alpine and subalpine environments. The philosophy behind this effort is that it is far less costly to prevent environmental degradation than to remedy it. It follows, then, that increased understanding of natural processes leads to better natural resource management.
We were able to use knowledge of the nitrogen cycle in Loch Vale Watershed this past year to work with the NPS Air Quality Division and the State of Colorado to respond to Prevention of Significant Deterioration permit requests from several potential new NO_x emission sources east of ROMO. We discovered in the process that our knowledge was sufficient to caution against increased emissions, but inadequate to clearly identify all possible sources and sinks of this very important anion. Part of the Loch Vale Watershed research effort in 1991 was devoted to increasing our understanding of high elevation nitrogen sources and sinks. While research is not complete, we discovered that summertime N fluxes are greater than wet-deposited N inputs, suggesting there is an additional, unmeasured source. The most plausible additional sources are dry deposition of nitrogen oxides transported from the Front Range urban corridor, and wet or dry deposition of atmospheric N_2 oxidized during thunderstorm events. The occurrence of NO_x aerosol has been documented at several high elevations in Colorado. Thunderstorms are a significant natural source of nitrogen oxides in the troposphere. While it has not yet been documented, it is possible there is enhanced deposition of nitrogen oxides in the vicinity of thunderstorm genesis zones. There are several thunderstorm genesis zones in the Colorado Front Range.

Loch Vale Watershed lake waters have higher concentrations of NO_3 than most other oligotrophic lakes, and higher concentrations than expected under the assumption that nitrogen is a biologically limiting nutrient. Three lakes in Loch Vale Watershed share this characteristic with nine other lakes (out of 147 total in the park). Regression analysis of lake NO_3 concentrations relative to elevation, slope steepness, and retention times did not reveal an association, unlike watersheds in eastern North America. A

possible association of NO_3 with vegetation needs to be explored further. Two inlets into Sky Pond, a headwater lake of Loch Vale Watershed, displayed slight, but consistent differences in NO_3 concentrations throughout the summer. We are exploring the possibility that one small watershed contains more biologically active tundra vegetation than the other. Research at the nearby Niwot Ridge Long-Term Ecological Research site show that N is strongly limiting to tundra growth.

Unlike tundra, subalpine forests of Loch Vale Watershed are not N-limited. Using the model CENTURY-Forest, we simulated the response of the mature spruce-fir forest in Loch Vale Watershed to 2 x N deposition. The trees were unable to take advantage of the additional N. Forest production showed a short-term increase, but declined to control conditions after 80 years, partly because subalpine forests are strongly constrained by temperature and moisture, and partly because old growth forests put more of their energy into respiration, which does not require a lot of N, than into new growth.

A second focus of research in 1991 was on hydrologic flowpaths. This work was conducted in conjunction with the USGS WEBB (Water, Energy, and Biogeochemical Budgets) project, and with the USGS Water Resources Division National Center. Three additional weather stations, three additional measured stream sections, and 20 ground water piezometers were installed by the WEBB scientists to explore detailed flowpaths associated with snowmelt. On a larger scale, we began a study of the importance of small headwater glaciers to late summer streamflow. This study makes use of the different stable oxygen-18 and deuterium isotope signatures of water formed at different temperatures. A simple hydrologic mixing model will use the isotopic ratios of snow, ice, and rain as surrogates for the volume of water supplied by glacial melt and rainfall for three lakes. Glacier meltwater, annual snowmelt, precipitation, and lake and stream water stable isotopic ratios will be compared between the Andrews Tarn watershed (30 percent glacier-covered), Sky Pond watershed (10 percent glacier-covered), and Loomis Lake watershed (0 percent glacier-covered).

Detailed hydrologic flowpaths, along with soil and surface water chemistry, will enhance our understanding of biogeochemical processes. This is important to our continued monitoring of pollutant pathways. Understanding the significance of glacial melt to hydrology will be important to predicting the ecosystem response to climate change. We cannot yet project whether changes in Rocky Mountain climate as a response to global changes in atmospheric trace gases or land use will lead to glacier

growth or glacier retreat. We can, however, document the current hydrologic importance of glaciers. This will put us in a better position to assess how changes will affect lake temperatures, stream discharge, and availability of aquatic organism habitat.

Studies on Nonpoint Source Pollution

by Del Wayne R. Nimmo
Research Environmental Chemist

Nonpoint Source Pollution and Our National Parks: Methods and Applications in the Use of Biomonitoring. This research was initiated in 1989 in response to land-use activities and their effects on water quality in parks--primarily the water coming in from outside of parks. Water quality in parks is often affected by nonpoint sources of pollution (i.e., those involving water not in defined pipes or conveyances and not subject to Federal or state effluent limits) that originate within or outside of parks. A major problem related to nonpoint source pollution in parks is encroachment around park peripheries by population and recreational centers. It is important that the NPS recognize and document changes in water quality in its units caused by nonpoint sources in a timely and cost effective way. The research described here applied such methods to park waters and is used for their management.

Biomonitoring is the use of living organisms as "sensors" in water quality surveillance to define quality of, and to detect changes in effluents or waters, and is used to indicate whether aquatic life may be endangered. In the past decade, the Environmental Protection Agency (EPA) has emphasized this approach as an indication of water quality in conjunction with criteria or standards for control of specific substances. Nonpoint research involves use of biomonitoring techniques developed in the laboratory and validated in field studies in park settings. This research differs from the approach used by EPA in two ways. The first is emphasis on chronic, sub-lethal endpoints, in addition to survival. The second is that four species, representing four diverse communities are used. EPA usually considers two communities represented by a daphnid and a fish. The objective of nonpoint pollution research is to use living organisms to assess water quality (the totality of all substances including toxicants, nutrients and natural substances derived from the watershed) in conjunction with, and not in place of, the more traditional chemical analyses. Usually, chemical analyses follow the initial biological assessment. Testing involves the following endpoints and organisms: the number of young produced by the small planktonic daphnid, *Ceriodaphnia dubia;* amount of food consumed by the benthic amphipod, *Hyalella azteca;* growth of larval fish, *Pimephales promelas,* and germination of grass seeds, *Echinochloa crusgalli.*

LABORATORY STUDIES

An artificially-prepared standard water has been developed for use under field conditions in parks. The objective of this research was to match the characteristics of the standard with natural waters (micronutrients, hardness, pH, alkalinity or other characteristics), which influence the responses of organisms to toxicants. The intent was to distinguish between the confounding characteristics of natural waters and subtle effects of toxicants on the endpoint of a test (i.e., the reproductive performance of a daphnid). The standard water developed in the laboratory has been used successfully in the Upper Delaware Scenic and Recreational River (New York) and the St. Croix National Scenic Riverway (Wisconsin).

Research has been completed on the application of Toxicity Identification Evaluation Procedures (TIE) to chronic testing of water within the parks. The approach uses chronic endpoints of organisms to detect the presence of toxicants during the first stages of testing. Understanding the physical/chemical characteristics of the toxicants provides information as to the appropriate analytical procedure to use and thus reduces the cost. An example of an element in the TIE procedure is to simply adjust the pH of the sample and to compare the toxicity of the sample before and after adjustment. If the solution with the lower pH is less toxic, the sample could have ammonia, cyanide, or perhaps some metals associated with the toxicity. Another procedure is to filter the sample and then conduct toxicity tests on both filtered and unfiltered sample to determine if the toxicity was associated with filtered material. This TIE was modified in the laboratory by extending the test beyond 48 hours and field testing at Wilson's Creek National Battlefield (Missouri).

ST. CROIX NATIONAL SCENIC RIVERWAY

A study of nonpoint source pollution from three cranberry operations adjacent to the Namekagon River, a tributary in the Park, was completed. The results showed significant decreases in reproduction of daphnids and decreased survival of fathead minnows in return waters from two of the cranberry operations. However, there was no evidence of effects on the organisms in water taken from the mainstem of the river below the return flows of the three areas. Chemical analyses of the two return flows which were toxic showed the herbicide, Dichlobenil, in one of the samples. This study suggests that further biomonitoring efforts should be conducted at various times of the cranberry growing period to determine if various practices such as fertilization, applications of pesticides, or harvesting affect the quality of return flows.

UPPER DELAWARE SCENIC AND RECREATIONAL RIVER

A study of nonpoint source pollution from a Superfund site near Narrowsburg, NY, was completed in September 1991. Leachates entering the Delaware River and Park were collected and sent to a cooperating laboratory at Colorado State University and tested for toxicity using the four test procedures outlined above. We found indications of toxicity in five of eight leachates with daphnids, three of eight with fathead minnows, and two of eight each for amphipods and grass seeds. Successive testing along the River was accomplished on-site with the daphnids, with the most toxic leachate shipped to the laboratory where its toxicity with fish and grass seeds was confirmed. Chemical analysis of this sample showed acetone, methylene chloride, and ammonia to be responsible for the toxicity, all chemicals that have been known to be lost or diminished through volatility or degradation during shipping. Findings from this study indicated (1) that assessments of toxicity should be made with a variety of test organisms; and (2) that testing on site was useful in prioritization of the degree of toxicity of the various leachates at this landfill.

FT. DARLING UNIT OF THE RICHMOND NATIONAL BATTLEFIELD PARK

Two studies were completed concerning nonpoint source pollution from a county landfill within the Ft. Darling unit located in Virginia. This site is perhaps unique in that the orange-red leachate discolors the entire stream flowing through and out of this Park. The site is a responsibility of the NPS and county. The first study determined if substances in leachate entering a small unnamed creek in the battlefield were toxic. The second study involved chemical analysis of the leachates. The first study showed that, despite the severe discoloration of the water by the leachate, the stream was neither acutely nor chronically toxic to animals or plants. Chemical analysis, however, demonstrated high concentrations of iron and aluminum in the leachate. Both of these metals are natural constituents in soils under and around the landfill and apparently are carried by ground water. Measurement of pH in monitoring wells around the landfill show a pH range of between three and five, probably the results of acidic soils. The metals are apparently carried via ground water into the landfill cavity where it is pooled. The leachate finally moves through the landfill material into the creek as Fe0. After reaching the creek and exposure to air, the metal oxidizes and precipitates out in the sediments as Fe_20_3. Because of precipitates in the sediments, there also may be a small amount of hydrated ferric oxide, which produces yellow color known as ferrous ferrite, Fe $(Fe0_2)_2$. Aluminum oxides may also be formed. The major conclusion of the

study is that there is severe armoring of the stream substrate, which severely affects establishment of permanent aquatic communities. However, we found no toxicity to aquatic life from water or sediments affected by the leachates.

WILSON'S CREEK NATIONAL BATTLEFIELD PARK

A project in June 1991, involved a repeat of a toxicological study of the watershed above the Park conducted in October 1989. In 1989 we found most of the tributaries and mainstem of the creek above the Park were toxic to daphnids, and confirmed what aquatic community studies had indicated earlier, i.e., severe impacts on communities of fishes and invertebrates from unknown sources upstream.

In the 1991 study, the segment below the Springfield (Missouri) Wastewater Treatment Plant was again toxic to the daphnids as found in 1989. Results of Toxicity Identification Evaluation procedures outlined above showed concentrations of copper and nickel exceeding the chronic limits for daphnids. Ammonia also exceeded state standards, and chloroform was found occasionally in the wastewater.

EVERGLADES NATIONAL PARK (FLORIDA)

A month-long survey of potential toxic conditions of waters in various canals was conducted in the Park. There was no indication of acute toxicity of sample waters to the four species. However, we noted the following:

There appeared to be an association (74 percent of the time) between three of the chronic endpoints and arbitrarily-derived categories of water quality from seven canals and two reference waters. The three endpoints showing the relationship consistently were the rates of food consumption of amphipods, growth rate of fathead minnows, and reproduction rate of daphnids. Of note was that the laboratory-derived standard water ranked in the highest category (quality), and the Pine Glades Lake, a "field-reference" water, met the second or fair category. The significance of this finding was that water quality cannot be judged on the appearance of the surrounding area or the water resource as was found at Fort Darling discussed above, and further that biomonitoring can be a valuable aid for prioritizing issues in water resource management plans.

In addition to effects on growth of larval fish, abnormal curvatures of the spines were found in larval fish exposed to canal waters that ranked in the fair and poor categories. Waters from three canals that ranked in the poor category deliver water to the same general area in the Park and all are in close proximity to an area of intensive agriculture. Oxygen depletion was found in some of the canals and further testing indicated conditions associated with high nutrient levels.

The above examples of biomonitoring to address nonpoint source issues in parks suggest the following:

- its use provides objectivity in the development of water management plans, i.e., that the appearance of waters does not necessarily correlate with its quality as was the situation in the small creek at Fort Darling and in the various canals in the Everglades;

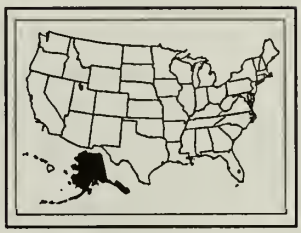
- it will aid in establishing priorities for addressing problem areas as in certain canals in the Everglades, selected cranberry marshes along the Namekagon River (St. Croix Riverway), and along the Upper Delaware River; and

- it can be used to discover certain substances contributing to toxicity in wastewater, which was one of the issues in the Wilson's Creek watershed.

Biomonitoring approaches appear to be effective tools to be used in conjunction with other methods in the protection of water resources in national parks.

SUPPORT PROVIDED TO REGIONS, PARKS, AND OTHER NPS ORGANIZATIONAL UNITS

ALASKA REGION



Planning and Evaluation Branch

- Cape Krusenstern NM
  Assessment of Red Dog Mine

- Denali NP
  Riparian Restoration Assistance

- Glacier Bay NP and PRES
  Evaluation of Proposed Windy Craggy Mine

- Yukon-Charley Rivers
  Water Resources Management Plan NPRES Scoping Report

Water Operations Branch

- Kenai Fjords NM
  Review Floodplain Compliance Statement of Findings

- Klondike Gold Rush NHP
  Provide an Assessment of River Bank Erosion and Working with Park to Develop Monitor Procedures

- Sitka NHP
  Evaluate River Bank Erosion and Recommend a Monitoring Program

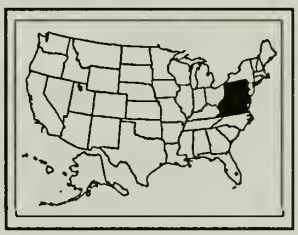
Applied Research Branch

✦ Cape Krusenstern NM
Assessment of Impact of Red Dog Mine Haul Road on Surface Water Quality

✦ Katmai NP
Assessment of Interagency Cooperative Geothermal Research
Participation on Katmai Science Experiments Review Panel
Participation on the Interagency Review Team for the Katmai EIS

✦ Noatak NM
Continued Assistance with Development of US/USSR Bilateral Research Planning Activities
Regionwide Assessment of Surface Water Chemistry
Provide Detailed Suggestions and Contacts for Design and Implementation of Estuarine Monitoring Program

MID-ATLANTIC REGION



Planning and Evaluation Branch

✦ Noatak NMColonial NHP
Water Resources Management Plan
Wetlands Assistance

✦ Delaware Water Gap NRA
Water Resources Management Plan

Water Operations Branch

✦ Assateague Island NS
Water Quality 1987-1990 Data Summary and Report for Chincoteague and Sinepuxent Bays

- ✦ Colonial NHP
  Review Ground Water/Wetland Relationships at Proposed Pipeline Crossing

- ✦ Fredricksburg and Spotsylvania NMP
  Review and Comment on Proposed NPDES Permit for Wilderness Corner Shopping Center

- ✦ Friendship Hill NHS
  Field Review and Comment on Final Draft Report "Use of a Constructed Wetland for the Treatment of Acid Mine Drainage at the Friendship Hill National Historic Site, Fayette County, PA"

- ✦ Gettysburg NMP
  Review Remedial Investigation/ Feasibility Study for Westinghouse Elevator Superfund Site

- ✦ Valley Forge NHP
  Provide Water Bath Incubator

Water Rights Branch

- ✦ Colonial NHP
  Assist with Water Resources Management Plan

Applied Research Branch

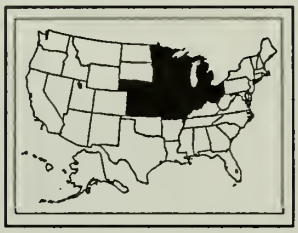
- ✦ Richmond NBP
  Study of Nonpoint Source Pollution from the Ft. Darling Landfill

- ✦ Shenandoah NP
  Continue Coordination with Watershed Monitoring Program

- ✦ Upper Delaware SRR
  Study of Nonpoint Source Pollution from the Cortese Superfund Landfill

✦ Wilson's Creek NB
Toxicological Survey and Toxicity Identification Evaluation of Wilson's Creek

MIDWEST REGION



Planning and Evaluation Branch

✦ Indiana Dunes NL
Wetlands Assistance

✦ Miscellaneous
Great Lakes Water Quality Initiative
Great Lakes Commission Observer
Great Lakes Commission - Ground Water Education Strategy Task Force

Water Operations Branch

✦ Cuyahoga Valley NRA
Ground Water Assessment of Haydite Mine
Preliminary Analyses of Statistical Models to Predict Fecal Coliform Concentrations in the Cuyahoga River

✦ Fort Larned NHS
Evaluate Potential for Restoring Streamflow by Removing Small Dam
Investigation into the Effects of the Removal of a Small Dam

✦ Indiana Dunes NL
Implement a PC-Based Graphical Water Quality Database Management and Mapping System within the Research Division

✦ Ozark NSR
Assisted PEB with Review of Natural Resources Management Plan

Water Rights Branch

- Agate Fossil Beds NM
  Inholder Irrigation Water Use

- Fort Larned NHS
  Kansas Abandonment Issue
  Private Diversion

Applied Research Branch

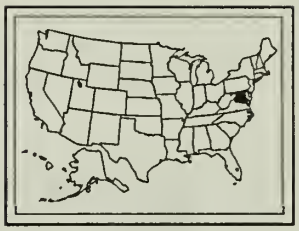
- Isle Royale NP
  Reviewed Watershed Research Program and Continued Support to Watershed Studies
  Mapping of Isle Royale Soils and their Potential Sensitivity to Atmospheric Contaminant Inputs
  Nonpoint Source Study of Impacts from Cranberry Operations

- Pictured Rocks NL
  Visited for Scoping on Resource Biodiversity Inventory and Monitoring
  Continued Monitoring of Little Beaver, Wallace Lake, and Sumner Lake Watersheds
  Detailed Study of the Causal Factors in Seepage Lake Acidification at Legion Lake

- Saint Croix Island NM
  Visited for Planning Meeting for Long-Term Monitoring of Aquatic Resources
  Nonpoint Source Study of Impacts from Cranberry Operations

- Regionwide
  Conducted Workshops at Agate, George Washington Carver, Wilson's Creek, Homestead, Herbert Hoover, and Pipestone for Water Quality Monitoring
  Represented the Midwest Region in the First BOREAS Workshop to Design Boreal Ecosystem Monitoring and Research Program Addressing Question of Global Change

NATIONAL CAPITAL REGION



Planning and Evaluation Branch

- ✦ Chesapeake and Ohio Canal NHP
  Wetlands Assistance

- ✦ National Capital Parks (East)
  Wetlands Assistance

Water Operations Branch

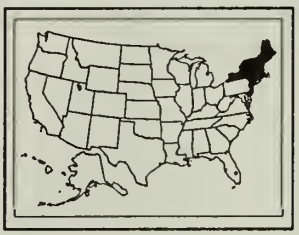
- ✦ Catoctin Mountain Park
  Developed Proposal to Mitigate Erosion on the Jaeger Tract

- ✦ George Washington Memorial Parkway
  Provision of 3-D Data to Park for Additional Analysis of Minnehaha Creek

- ✦ National Capital Parks (East)
  Assistance with Analysis of Impacts of Fort Lincoln New Town Development on Anacostia River Wetlands

- ✦ Prince William Forest Park
  Well Drilling
  Assist in Evaluating Water Quality Issues Stemming from Acid Mine Drainage

NORTH ATLANTIC REGION



Planning and Evaluation Branch

- ✦ Fire Island NS
  Water Resources Management Plan Scoping Report

Water Operations Branch

✦ Cape Cod NS
Model Impact of Ground Water Withdrawals on Freshwater Discharges to Wetlands

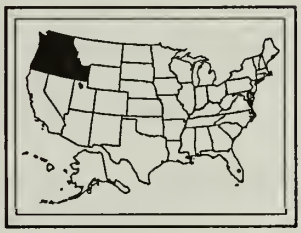
✦ Fire Island NS
Training on Field Methods for Bacteriological Analysis
Analyses of Alternatives for the Abandonment of Flowing Wells

✦ Gateway NRA
Assisted in Natural Resources Program Review and Operations Evaluation

✦ Salem Maritime NHS
Review of Floodplain Compliance Statement of Findings

PACIFIC NORTHWEST REGION

Planning and Evaluation Branch



✦ Coulee Dam NRA
International Joint Commission Lecture and Analysis of Cominco Metals Discharge Permit
Water Resources Management Plan

Water Operations Branch

✦ Coulee Dam NRA
Review and Comment on Request for Extension of Effluent Permits at Cominco Ltd. Metallurgical Works at Trail, British Columbia

✦ Hagerman Fossil Beds NM
Review and Evaluation of the Relationship of Ground Water to Landslides on the Hagerman Plateau

- John Day Fossil Beds NM
  Floodplain Map of the Cant Ranch Area
  Provide Assistance in Locating, Development, and Design of Additional Potable Water Supplies

- Mount Ranier NP
  Technical Review of GIS Section of MORA's Natural Resource Management Plan as it Pertains to Water Resources

- Oregon Caves NM
  Assist in Developing Hydrologic Study to Determine Baseline Water Quality Conditions

Water Rights Branch

- City of Rocks NR
  Snake River Adjudication

- Crater Lake NP
  Klamath Adjudication
  State Water Rights Reports

- Craters of the Moon NM
  Snake River Adjudication

- Olympic NP
  Elwah River Diversions

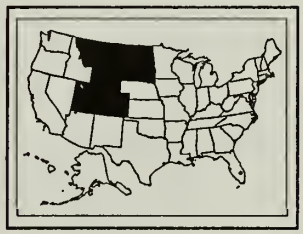
- Miscellaneous
  Snake River Negotiations

Applied Research Branch

✦ Crater Lake NP
Assistance with Technical Support and Peer Review of the Geothermal Studies and Reports to Congress

✦ Olympic NP
Continued Support to Watershed Studies
Participation with Technical Review of the Congressionally Mandated Lake Studies

ROCKY MOUNTAIN REGION



Planning and Evaluation Branch

✦ Bighorn Canyon NRA
Water Resources Management Plan Scoping Report

✦ Capitol Reef NP
Water Resources Management Plan

✦ Dinosaur NM
Wetlands Investigation

✦ Glen Canyon NRA
Analysis of Hazardous Waste Disposal Issues
Interagency Proposal for Trace Element Study

✦ Grand Teton NP
Water Resources Management Plan

✦ Jewel Cave NM
Water Resources Management Plan Scoping Report

- ✦ Pipe Spring NM
  Waste Incinerator Environmental Impact Statement

- ✦ Rocky Mountain NP
  Wetlands Assistance

- ✦ Timpanogos Cave NM
  Wetlands Assistance

- ✦ Yellowstone NP
  McLaren Mill Tailings CERCLA Removal Action
  Wetlands Assistance
  Review of Noranda Plan of Operations

- ✦ Zion NP
  Wetlands Assistance

- ✦ Miscellaneous
  Western Area Power Administration Power Marketing Environmental Impact Statement

Water Operations Branch

- ✦ Agate Fossil Beds NM
  Investigate Potential for Impacts on Park Water Resources from Offsite Activities

- ✦ Badlands NP
  Ground Water Supplies

- ✦ Dinosaur NM
  Riparian Area Restoration Project in Hog Canyon

- Florissant Fossil Beds NM
  Evaluate Water Quality Impacts from a Private Campground Development

- Fort Laramie NHS
  Address Ground Water Concerns
  Delineation of 500-year Floodplain

- Glacier NP
  Assistance with the Divide Creek Flooding Issue

- Glen Canyon NRA
  Review of Wahweap Marina Contaminant Sample Data
  STORET Retrieval from 1970 to Present of Various Water Quality Parameters in Lake Powell
  Assistance on Glen Canyon Dam Environmental Studies

- Grand Teton NP
  Assistance in a Study of the Effect of Removal of River Gravel for use in Road Reconstruction
  Review of Floodplain Compliance Statement of Findings

- Grant-Kohrs Ranch NHS
  Investigation into Stream Bank Erosion

- Jewel Cave NM
  Analysis of Potential Impacts to the Water Resources of Jewel Cave National Monument From Highway 16 Re-Alignment

- Natural Bridges NM
  Ground Water Pumping Impact Assessment

- Pipe Spring NM
  Ground Water Monitoring to Determine the Decline of Spring Flow in the Park

- ✦ Rocky Mountain NP
  - Floodplain Map of the Wild Basin Corridor
  - Assistance to Address Concerns About Diverting Water for Snowmaking from Hidden Valley Creek

- ✦ Theodore Roosevelt NP
  - Review of Water Quality Issues Related to Oil and Gas Development

- ✦ Yellowstone NP
  - Investigate Abandoned Trout Creek Dumpsite Water Quality Concerns
  - Recommend Monitoring Program for Water Quality in Marina at Bridge Bay
  - Review of Water-Related Project Statements in Preliminary Draft of Resource Management Plan

- ✦ Zion NP
  - Floodplain Map of the Visitor Center Area

Water Rights Branch

- ✦ Bent's Old Fort NHS
  - Water Right Filing

- ✦ Bighorn Canyon NRA
  - Wyoming Water District III Adjudication
  - Reserved Water Right Questions

- ✦ Black Canyon of the Gunnison NM
  - Aspinall Flow Delivery Contract
  - Assist with Natural Resources Management Plan
  - Quantify Water Right

- ✦ Bryce Canyon NP
  - Ground Water Study (Alton, Utah Area)

- Canyonlands NP
  - Water Right Filing

- Capitol Reef NP
  - Wayne County Water Rights Application
  - FERC Application
  - Assist with Water Resources Management Plan

- Cedar Breaks NM
  - Adjudication Claims

- Dinosaur NM
  - Acquire Water Rights for Stream Flow

- Florissant Fossil Beds NM
  - File for Change
  - Assist with Water Rights Plan

- Fossil Butte NM
  - Register Well

- Glacier NP
  - Adjudication Study

- Glen Canyon NRA
  - New Escalante Irrigation Water Right Application
  - Colorado River Adjudication

- Grand Teton NP
  - Assist with Water Resources Management Plan
  - Adjustment of Acquired Water Rights

- Grant-Kohrs Ranch NHS
  - Westside Ditch Company Fee Assessment
  - Atlantic Richfield Company Diversion
  - Montana Adjudication, Basin 76G

- Great Sand Dunes NM
  - Well Registration
  - Dune Core Study

- Mesa Verde NP
  - Adjudication Study

- Pipe Spring NM
  - Spring Decline Study

- Rocky Mountain NP
  - Respond to Court
  - Snowmaking Study
  - Water Rights Plan
  - Review Impact of Pickrell Diversion
  - Register Replacement Wells
  - Protest Diversion by Girl Scouts
  - Assist with Resource Management Plan
  - Adjudication Study
  - Assist with Strategy to Protect Mirror Lake

- Wind Cave NP
  - Assert Vested Rights

- Yellowstone NP
  - Implement Reese Creek Settlement Agreement
  - Montana Adjudication, Basin 43B
  - Assess Potential for Impact Due to Development of Corwin Springs Known Geologic Structure
  - Assess Impact of McLaren Mine Tailings
  - Greater Yellowstone Ecosystem Document Review
  - Adjudication Study

✦ Zion NP
Freedom of Information Act Response
Adjudication Studies
Protect Flanigan Ditch Claim
Review Municipal and Industrial Water Use Report
Water Supply Index

✦ Miscellaneous
Respond to Montana Temporary Preliminary Decrees

Applied Research Branch

✦ Black Canyon of the Gunnison NM
Analyzed Hydrologic Data and Flow Hydrographs for WRB in Support of Water Rights Issues

Provided Technical Direction and Served as a Graduate Committee Member for Thesis Regarding "Entrainment of Gravel and Cobbles by River Flows at BLCA" in Support of the WRB and Water Rights Issues

✦ Capitol Reef NP
Assisted with Watershed Monitoring Proposal

✦ Grand Teton NP
Provided Technical Support to the Park and DSC Regarding Efforts by Federal Highway Administration for the Removal of Gravel from Stream Beds

✦ Rocky Mountain NP
Continued Support to Watershed Studies
Co-edited the Lawn Lake Flood Monograph with ROMO Staff
Long-Term Ecological Research in Loch Vale
Assisted with Natural Resource Management
Assisted with Global Change Research Proposals

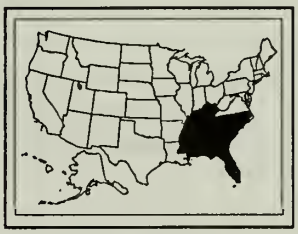
✦ Yellowstone NP

Assistance with Interagency Coordination and Review of Corwin Springs Known Geothermal Area Research Reports to Congress

✦ Zion NP

Provided Input and Review as Graduate Committee Member for Thesis Regarding "Synthesis of Long Term Flow Record for the East Fork of the Virgin River in Zion NP" in Support of the WRB and Water Rights Issues

SOUTHEAST REGION



Planning and Evaluation Branch

✦ Big Cypress NPRES

Water Resources Management Plan
General Management Plan/Minerals Management Plan
Environmental Impact Statement

✦ Big South Fork NR & NRA

Water Resources Management Plan

✦ Blue Ridge Parkway

Wetlands Assistance

✦ Congaree Swamp NM

Water Resources Management Plan

Water Operations Branch

✦ Biscayne NP

Review and Comment on South Dade County Landfill Ammonia Remediation Proposal

- ✦ Big Cypress NPRES
  Review of floodplain compliance Statement of Findings

- ✦ Canaveral NS
  Phase I Mosquito Lagoon Environmental Resources Inventory

- ✦ Chattahoochee River NRA
  Provided Guidance for Bacteriological Monitoring of Recreational Waters

- ✦ Everglades NP
  Review South Florida Water District Settlement
  Review Surface Water Improvement Management Plan

- ✦ Virgin Islands NP
  Assistance in Design of a Water Resources Project to Assess Effects of Land Development on Watershed Erosion

Applied Research Branch

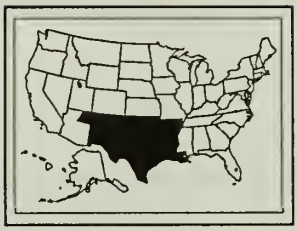
- ✦ Biscayne NP
  Technical Assistance and Chemical Analysis of Leachate from the South Dade County Landfill

- ✦ Everglades NP
  Survey of Nonpoint Source of Pollutants in Canals Delivering Water to the Everglades

- ✦ Great Smoky Mountains NP
  Assistance in Evaluation of Drainage from Abandoned Mines

- ✦ Virgin Islands NP
  Assistance in Developing GIS Aspects of Watershed Erosion Project

SOUTHWEST REGION



Planning and Evaluation Branch

- Arkansas Post N MEM
  Evaluation of Corps of Engineers Proposal
- Bandelier NM
  Water Resources Management Plan
- Big Bend NP
  Water Resources Management Plan Scoping Report
- Buffalo NR
  Water Resources Management Plan
- Chickasaw NRA
  Natural Resources Management Plan
- Miscellaneous
  Review of Arkansas Groundwater Legislation

Water Operations Branch

- Big Bend NP
  Reconnaissance Level Flood Hazard Assessment
- Buffalo NR
  EPA Nonpoint Source Program Assessment Outline
- El Malpais NM
  Test Well Drilling to Locate Potable Water Supply
- Hot Springs NP
  Review COE Flood Control Proposal

- Jean Lafitte NHP
  Consultations on GIS Water Resources Applications and Systems Suitable to Review of Floodplain Compliance Statement of Findings

- Pecos NM
  Develop Water Quality Monitoring Program
  STORET Retrieval in Support of Water Quality Monitoring Program Development

- Petroglyph NM
  Preliminary Investigation of Erosion and Sedimentation Problems

Water Rights Branch

- Aztec Ruins NM
  Assess Acquired Water Right

- Bandelier NM
  Assist with Water Resources Management Plan

- Big Bend NP
  Assist with Water Resources Management Plan Scoping Report

- Buffalo NR
  Assess Safe Yield
  Review Arkansas Water Management Plan
  Assist with Water Resources Management Plan

- Carlsbad Caverns NP
  Private Diversion

- Chickasaw NRA
  Spring Monitoring

✦ Pecos NM
Assist Park with Grist Mill and Acequia Issues

✦ Petroglyph NM
Assess Water Rights for New Park

✦ San Antonio Missions NHP
Acequia Renewal

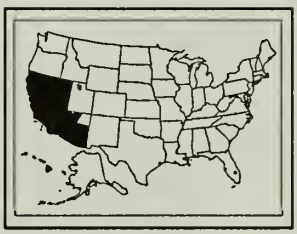
✦ White Sands NM
Assert Water Right

Applied Research Branch

✦ Bandelier NM
Technical Assistance Regarding Contamination in the Park

WESTERN REGION

Planning and Evaluation Branch



✦ Death Valley NM
Evaluation of High-Level Radioactive Waste Repository and Nevada Test Site
Wetlands Assistance

✦ Golden Gate NRA
Water Resources Management Plan Scoping Report
Assessment of Water Resources at Presidio of San Francisco

✦ Grand Canyon NP
Glen Canyon Environmental Studies
Evaluation of Bureau of Reclamation Operating Criteria for Colorado River Facilities

- Great Basin NP
  Water Resources Management Plan and General Management Plan

- Joshua Tree NM
  Water Resources Management Plan Scoping Report

- Lake Mead NRA
  Wetlands/Riparian Restoration Assistance

- Lassen Volcanic NP
  Wetlands Assistance

- Organ Pipe Cactus NM
  Water Resources Management Plan

- Point Reyes NS
  Water Resources Management Plan Scoping Report

- Redwood NP
  Wetlands Assistance

- Sequoia/Kings Canyon NP
  Water Resources and Wetlands Assessments

- Miscellaneous
  Colorado River Jurisdictional Study

Water Operations Branch

- American Memorial Park
  Review Report on Field Investigation of Beach Erosion

- Death Valley NM
  Review Flood Mitigation Study

- Fort Bowie NHS
  - Well Drilling

- Golden Gate NRA
  - Sole Source Aquifer Assessment for the Presidio

- Grand Canyon NP
  - Assistance in Design of Interim Flow Prescription for Glen Canyon Dam
  - Beach Erosion Research
  - Beach Ground Water Monitoring
  - Development of Sediment-Discharge Model for Colorado River
  - Evaluate Project Proposal for Study of Hydrogeology of the South Rim and Potential Threats to Spring Discharge in the Canyon
  - Review Water Quality Monitoring Program
  - Technical Review of GIS Work for Nankoweap Reach and Long-Term Monitoring as Part of GCES

- Great Basin NP
  - Assist with Water Resources Management Plan

- Kaloko-Honokohau NHP
  - Review and Comment on Kohaniki Monitoring Program

- Point Reyes NS
  - Participate in Scoping Meeting for Natural Resources Management Plan

- Organ Pipe Cactus NM
  - Floodplain Map of the Visitor Center Area

- Sequoia/Kings Canyon NP
  - Delineation of 500-year floodplain

- Yosemite NP
  - Study of the Effects to the Merced River Resulting from Restoration of El Capitan moraine to historic elevation

✦ Miscellaneous
Representation on Bureau of Reclamation Colorado River Annual Operating Planning Workgroup

Water Rights Branch

✦ Casa Grande NM
Adjudication Study
Assist with Natural Resources Management Plan

✦ Coronado NM
Support Adjudication Claims

✦ Death Valley NM
Monitor Devil's Hole
Monitor U.S. Nevada Gold Search Joint Venture
Monitor U.S. Department of Energy Water Use
Protest Las Vegas Valley Water District Applications
Protest Marsh Application
Protest Rissinger Application
Protest Industrial Minerals Venture Application
Protest Phoenix Inn Application
Protest Selbach Application
Research Harvey Agreement
File Reports/Changes for NPS Rights
Protest Magma Mining Water Rights Application
Orders for Correction

✦ Fort Bowie NHS
Mine Tunnel Spring Application
Apache Spring Application
Headquarters Well Water Rights
Support Adjudication Claims

- Golden Gate NRA
  - Stinson Beach Water Rights
  - Protect Redwood Creek
  - Assist with Water Resources Management Plan
  - Presidio Transfer

- Grand Canyon NP
  - Tusayan Request
  - Glen Canyon Environmental Studies

- Great Basin NP
  - Review Garrett Claim
  - Administration Site Withdrawal
  - Assist with Water Resources Management Plan and General Management Plan
  - Protest Las Vegas Valley Water District Application

- Kalaupapa NHP
  - Waikolu Stream Study

- Lake Mead NRA
  - Review Applications
  - Basin Designation
  - Protest Las Vegas Valley Water District Application
  - Protest Magma Mining Water Rights Application
  - Lassen Volcanic NPReplace Water Supply
  - Notice of Unavailability
  - Reports of License
  - Martin Creek Water Right Statement

- Montezuma Castle NM
  - Review Water Rights
  - Adjudication Study
  - Assist with Management Plan EA

- Organ Pipe Cactus NM
  - Assist with Water Resources Management Plan
  - Mexico Ground Water Impacts

- Point Reyes NS
  - File Reports/Changes
  - Assess Water Rights for Lagunitas Creek
  - Assist with Water Resources Management Plan Scoping Report

- Redwood NP
  - Protect Requa Well 3
  - Orders for Correction

- Saguaro NM
  - U.S. Forest Service Water Use
  - Support Adjudication Claims

- Walnut Canyon NM
  - Walnut Canyon Flows
  - Protest Santa Fe Dam
  - Assist with Natural Resources Management Plan
  - Support Adjudication Claims

- Miscellaneous
  - San Pedro Adjudication
  - Monitor Nevada Application
  - Little Colorado Adjudication
  - Hawaii Water Code Review
  - Basin Closure
  - Declare Water Rights
  - Assist Region on Drought
  - Phoenix Indian School

Applied Research Branch

✦ Great Basin NP
Provided Input to a Global Climate Change Operation and Research Plan

✦ Sequoia/Kings Canyon NP
Review and Continued Support to Watershed Studies
Provide Water Quality Analyses for Long-Term Watershed Studies

SERVICEWIDE

The Water Resources Division contributed to numerous servicewide projects this year. Examples are provided under the categories of policy assistance, regulatory guidance, publications and training, technical assistance, and program coordination.

✦ The WRD provided **servicewide policy assistance** to the Directorate and Secretariat through the following: reviewed and coordinated servicewide comments on the Proposed Federal Manual for Identification of Jurisdictional Wetlands, reviewed proposed legislation for reauthorization of the Clean Water Act, represented the service in interagency policy forums to assist the department in determining an administration position for the reauthorization of the Clean Water Act, reviewed of NPS water policy provisions of the service and the department, and commented on NPS program planning and policy documents to assist in integrating plans with current NPS water policies and programs. In addition, the WRD continued to reorganize the water rights docket information to assist with its preservation as well as increase its usefulness and accessibility in the future.

✦ In the area of **servicewide regulations and guidelines**, WRD conducted a prototype study of the adequacy of state water quality standards to protect park water resources, assisted in drafting regulations to implement a ban on solid waste disposal facilities in units of the National Park System, provided guidance on EPA Stormwater Regulations, provided servicewide guidance on NPS Wetlands Protection Guidelines, reviewed proposed regulations affecting waters of the National Park System, and drafted revisions to the NPS Floodplain Management Guidelines. WRD reviewed and assisted in preparing over a dozen Statements of Findings (SOF) for construction projects

proposed in park units. These SOF's were reviewed or revised so as to protect floodplains and wetlands values in units of the National Park System.

✦ Contributions to **servicewide publications and training** included the following: reviewed and assisted in drafting NPS-53, NPS-75, and NPS-77, prepared articles for NPS *Highlights*, prepared a paper on the Devil's Hole and water resource issues, provided servicewide training to "Natural Resource Management Trainees", and presented water resource issues to "Critical Natural Resource Issues for Superintendents," "Ranger Skills," and "Facility Managers" training courses. WRD further provided lectures during the Servicewide Hazardous Waste Training Course on the Clean Water Act and its Relationship to the Management of Hazardous Materials and participated in the NPS Recreation Instream Flow Workshop.

✦ The WRD provided **servicewide technical assistance** through the following: participated in a workshop assembled to develop guidance for the use of borrow pits on NPS property, represented the NPS in Colorado River annual operations planning, evaluated the USGS Spatial Data Transfer Standard for water resources applications, initiated the water resources inventory and monitoring data management, and administered the prototype GIS project, and began to develop a servicewide water quality management data system.

Servicewide water resource program goals with other servicewide and departmental program goals were integrated through the participation in the USGS National Water Quality Assessment Program, the participation on several subcommittees of the Departmental Committee on Water Data, the assistance to the USGS with NASQUAN, WEBB, Benchmark, and Global Climate Change Programs, the service on the Interagency Fresh Water Initiative Coordinating Council, the participation in Water 2000 to develop a broad consensus on future national water quality goals, and the continued participation on departmental and interagency Wetlands Policy Working Groups.

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FINANCIAL STATUS OF THE WATER RESOURCES DIVISION

by Stan Ponce
Division Chief
and Debi Cox
Program Analyst

FY92 base funding for the WRD is $6,104,000. Figure 1 illustrates the distribution of total WRD funds among technical assistance, project, and administrative overhead costs. Technical assistance, which is predominately day-to-day operational support to the parks, Regions, and other NPS organizational units, includes staff salaries, travel, and associated expenses. Administrative overhead includes program management costs, administrative support, equipment, and supplies and materials Divisionwide. The project category includes funds supporting WRD-sponsored projects, such as WRD prioritized projects, water rights studies, and our research program; staff salaries and associated overhead are not included. Tables 1, 2, 3, 4, and 5 summarize WRD-sponsored projects and studies. Tables 6 and 7 include water quality and wetlands projects that were only funded in FY91. These funding levels are not included in figure 1.

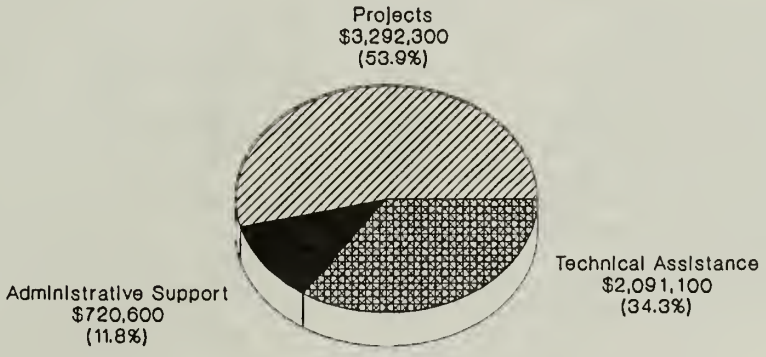


FIGURE 1. Distribution of WRD Program FY92 Funding.

TABLE 1. LISTING OF WRD PRIORITIZED PROJECTS
Fiscal Year 1992

REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	FY92	FY93	FY94	WRD PROJECT COORDINATOR
SER	MACA	Groundwater Study	155.0	50.0			Rosenlieb
MWR	SLBE	Water Quality Inventory	75.0	25.0			Rosenlieb
NCR	RWIDE	Urban Stream Improvements	75.0	25.0			Jackson
WR	GRBA	Water Resources Management Plan	66.0	22.0			Flora
WR	MOCA	Identify/Inventory Water Related Resources	150.0	50.0			Werrell
MAR	DEWA	Develop and Test Water Quality	70.0	20.0			Rosenlieb
MWR	OZAR	Water Resources Mgmt. Studies	110.0	15.0			Rosenlieb
NAR	ACAD	Estuarine Impacts from Overboard Discharges	160.0	40.0			Rosenlieb
SWR	ELMA	Survey Water Resources Status	69.0	20.0			Werrell
AR	KATM	Water Resources Baseline	135.0	60.0			Rosenlieb
SER	CANA	Sewage Effluent, Mosquito Lagoon	100.0	42.5			Rosenlieb
NCR	MANA	Stream Quality and Sedimentation Study	95.0	30.0	30.0		Inglis
MAR	COLO	Water Resources Management Plan	80.0	40.0			Flora
PNR	CRLA	Crater Lake Ecosystem	120.0	60.0			Herrmann
SWR	BUFF	Water Quality Monitoring	81.0	27.0	27.0	27.0	Rosenlieb
AR	GAAR	Water Resources Baseline	110.0	10.0	50.0	50.0	Rosenlieb
SER	VIIS	Effects of Sedimentation	80.0	20.0	40.0	20.0	Tucker
PNR	MORA	Jokulhlaup Prediction Study	120.0	40.0	40.0	40.0	Herrmann
RMR	GLCA	Water Resources Monitoring	62.0	31.0	31.0		Rosenlieb
SER	BICY	Develop Water Resources Mgmt Plan	50.0	50.0			Sharrow
PNR	ORCA	Monitoring Cave Water Quality	23.6	14.0	9.6		Martin
WR	ORPI	Geohydrology of Quitobaquito Management Area	48.0	48.0			Werrell
NCR	PRWI	Determine Impact on Water Quality Ground Water at Abandoned Mine	36.0	19.0	17.0		Rosenlieb

TABLE 2. PROJECTS FUNDED THROUGH THE WATER QUALITY ACTIVITY
Fiscal Year 1992

REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	FY92	FY93	FY94	WRD PROJECT COORDINATOR
MAR	ASIS	Water Quality Monitoring for ASIS	40.0	20.0			Rosenlieb
MWR	SACR	Identification of Water Quality and Flow Characteristics Affecting the Life History of Quadrula Fragosa	24.4	12.5			Rosenlieb
MWR	VOYA	Mitigating Mercury in NE Minnesota Rivers, Lakes, and Reservoirs	40.0	20.0			Rosenlieb
NAR	ACAD	Water Quality in Somes Sound - A Preliminary Evaluation	40.0	20.0			Rosenlieb
RMR	CARE	A Proposal to Monitor the Quality of Waters within the Fremont River Watershed	40.0	20.0			Rosenlieb
RMR	JECA	Water Quality Monitoring Proposal for Wind and Jewell Cave	40.0	20.0			Rosenlieb
SER	MACA	Pesticide Monitoring in Mammoth Cave	20.0	10.0			Rosenlieb
PNR	MORA	Human Waste Management in Backcountry Areas	40.0	20.0			Rosenlieb
NCR	CATO	Mitigate Sediment Transport from the Jaeger Tract	37.1	20.0			Rosenlieb
MWR	CUVA	Assess IJC Chemical Parameters	37.0	25.0	12.0		Rosenlieb
WR	KAHO	Study Contamination of Anchialine Ponds	40.0	20.0	20.0		Rosenlieb
RMR	GLAC	Identify Septic Systems Impacting Lake McDonald	10.0	10.0			Rosenlieb
MAR	DEWA	Establish Water Quality Baseline for Nutrients of Tributaries to the Delaware River	70.0	35.0	35.0		Rosenlieb
PNR	CRMO	Develop Baseline on Water Resources	40.0	20.0	20.0		Rosenlieb
AR	CAKR	Determine the Effects of the Red Dog Mine Haul Road on Water Quality and Macroinvertebrate Populations	13.6	13.6			Rosenlieb

TABLE 3. PROJECTS FUNDED THROUGH THE WETLANDS ACTIVITY
Fiscal Year 1992

REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	FY92	FY93	FY94	WRD PROJECT COORDINATOR
SER	COSW	Wetlands Inventory	40.0	40.0			Wagner
NCR	NACE	Characterization of Wetlands and Water Sources	20.0	20.0			Wagner
NAR	CACO	Salt Marsh Restoration	40.0	25.0	15.0		Wagner
MAR	ASIS	Wetland Resources Assessment	40.0	20.0	20.0		Wagner
AR	DENA	In-Stream and Riparian Restoration on Watersheds Disturbed by Mining	36.7	36.7			Wagner

TABLE 4. PROJECTS FUNDED THROUGH THE WATER RIGHTS PROGRAM*
Fiscal Year 1992

REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	FY92	FY93	FY94	WRD PROJECT COORDINATOR
WR	DEVA LAME GRBA	Las Vegas Valley Water District	276.0				Johns
RMR	ZION	Virgin River Adjudication	235.0				Hansen
RMR	ROMO	Colorado Water Division I Adjudication	128.0				McGlothlin
PNR	CRLA	Klamath River Adjudication	30.0				Pettee
RMR	BLCA	Quantification Reserved Rights	10.0				Pettee
RMR	GLAC	Montana Statewide Adjudication	70.0				Hansen
WR	DEVA	Ground Water Model	80.0				Christensen
WR	DEVA	Nevada Water Resource Experts (non-LVVWD)	15.0				Hughes
PN/RM	CIRO CRMO HAFO NEPE YELL	Snake River Adjudication	45.0				Pettee
RMR	GRSA	Water Rights Monitoring	10.0				McGlothlin
WR	KALA	Instream Flow Study	71.0				Hansen
WR	DEVA	Springs Survey	20.0				Christensen
RM	YELL	Montana Statwide Adjudication	60.0				Albright

*Funds listed in the above table are in direct support of water rights needs at these parks; in many cases funds are not transferred to the park or region but are administered by the Division.

TABLE 5. SUMMARY OF OTHER PROJECT AREAS SUPPORTED BY WRD FUNDS
Fiscal Year 1992

Water Resources Studies at Everglades NP	$500,000
Watershed Studies Research Program (WRD-CPSU)	$395,000
Applied Research Branch Studies	$161,000

Monitoring Strategies and Biological Assessment for Park Waters	$60,000	Boyle and Hoefs
Application of Computer Modeling for Management of Park Water Resources	$39,700	Flug and Diaz
Risk Assessment of Point and Non-Point Sources of Pollution from within and outside Parks	$29,000	Nimmo
Evaluation of Water and Sediment Quality in Parks	$20,000	Walsh

In addition, administrative costs are 12,300 for a total of 161,000.

TABLE 6. WATER QUALITY PROJECTS ONLY FUNDED IN FY91

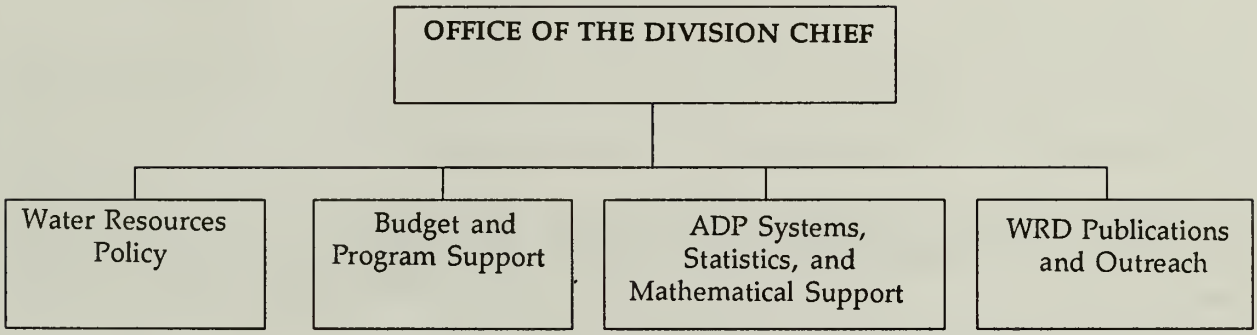
REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	WRD PROJECT COORDINATOR
AR	WRST	Effects of Commercial and Concessions Operations on QW	13.0	Rosenlieb
SER	BISC	Water Quality Monitoring	19.0	Rosenlieb
SWR	BUFF	Water Quality Monitoring	20.0	Rosenlieb
SWR	Multi-	Adequacy of State Water Quality Standards for Protecting Water and Related Resources in nine NPS units in Texas	5.0	Rosenlieb

TABLE 7. WETLANDS PROJECTS ONLY FUNDED IN FY91

REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	WRD PROJECT COORDINATOR
AR	YUCH	Wetlands Inventory	25.0	Wagner
NAR	ACAD	Wetlands Inventory	22.6	Wagner
MAR	COLO	Wetlands Inventory	20.0	Wagner
PNR	NOCA	Wetlands Inventory	15.5	Wagner
NCR	GWMP	Dyke Marsh Inventory	3.2	Wagner
SWR	PECO	Wetlands Inventory	18.5	Wagner
RMR	GLAC	Wetlands Inventory	18.5	Wagner
RMR	DINO	Hog Canyon Spring/Riparian System Rehabilitation	12.0	Wagner
WR	LAME	Spring Habitat Restoration	21.0	Wagner
Servicewide		Wetlands Brochure	15.0	Wagner

OFFICE OF THE DIVISION CHIEF

Organization and Staff



Stan Ponce: Division Chief, PhD in Civil and Environmental Engineering. Specialty areas include water resources policy, natural resources management, water law, and upland hydrology.

Pam Matthes: Water Resources Program Coordinator, MS in Zoology. Specialty areas include natural resource management policy, environmental law and regulation, wildlife management, and wetlands ecology.

Dave Ryn: Mathematician, MS in Mathematics. Specialty areas include computer and statistical technology.

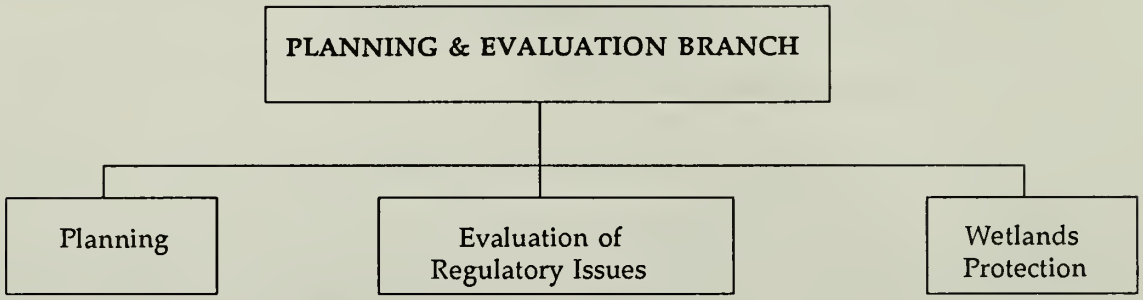
Debi Cox: Program Analyst.

Judy Rouse: Secretary.

Carol Liester: Clerk/Typist.

PLANNING AND EVALUATION BRANCH

Organization and Staff



Dan Kimball: Branch Chief, MS in Water Resources Administration. Specialty areas include water and natural resources management planning and evaluation of complex regulatory issues.

Barbara West: Environmental Protection Specialist, MA in Public Administration. Specialty areas include regulatory support and evaluations.

Mark Flora: Hydrologist, MS in Environmental Science. Specialty areas include water resources management planning.

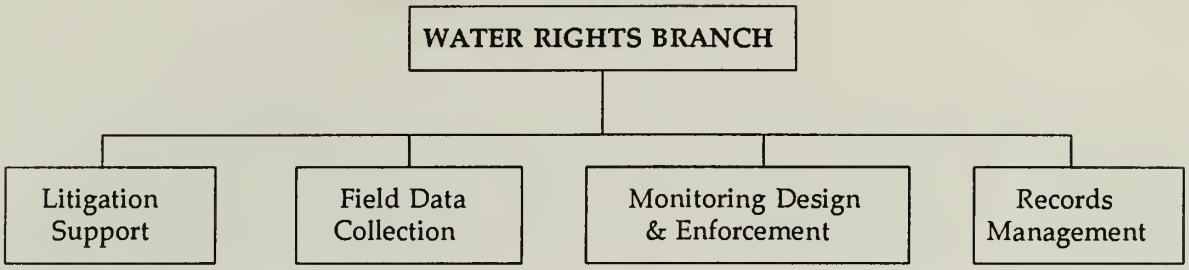
Joel Wagner: Hydrologist, MS in Environmental Science. Specialty areas include wetlands identification and protection.

David Sharrow: Hydrologist, BS in Watershed Science. Specialty areas include water resources management planning.

Bonnie Allison: Secretary.

WATER RIGHTS BRANCH

Organization and Staff



Owen Williams: Branch Chief, MS in Watershed Sciences. Specialty areas include water law, upland watershed management, fluvial geomorphology, and surface water hydrology.

Chuck Pettee: Team leader, MS in Watershed Science. Specialty areas include surface water hydrology and hazardous materials.

Dan McGlothlin: Team leader, BS in Watershed Hydrology. Specialty areas include surface water hydrology and land resource management.

Paul Christensen: Hydrologist, MS in Geology. Specialty areas include ground water hydrology, hydrogeochemistry, and computer modelling.

Bill Hansen: Hydrologist, MS in Hydrology. Specialty areas include surface water hydrology and watershed rehabilitation.

Alice Johns: Hydrologist, BS in Watershed Sciences. Specialty areas include surface water hydrology and field methods.

Jeff Albright: Hydrologist, MS in Watershed Management. Specialty areas include surface water hydrology, field methods, instrumentation.

Jeff Hughes: Hydrologist, MS in Watershed Sciences. Specialty areas include surface water hydrology, field methods, instrumentation.

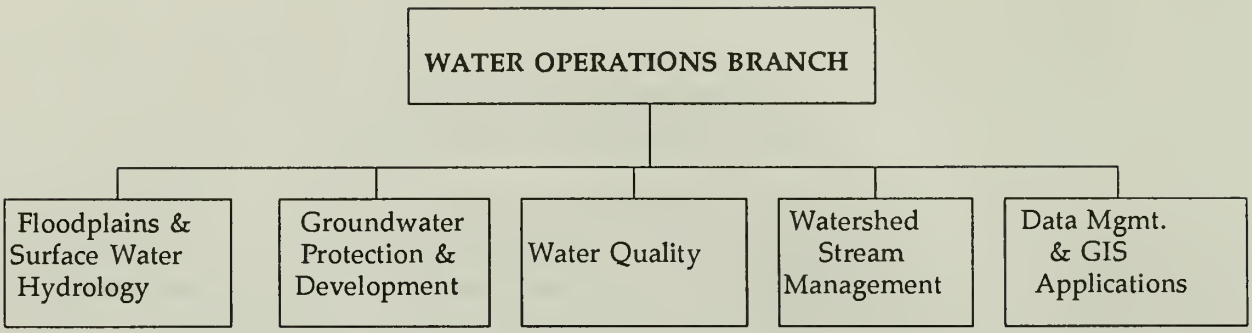
Andrew Hautzinger: Research Associate; CSU - Civil Engineering.

Janice Taylor: Secretary.

Bernadette Berger: Clerk Typist; CSU - Work Study.

WATER OPERATIONS BRANCH

Organization and Staff



Bill Jackson: Branch Chief, PhD in Forest Hydrology. Specialty areas include sedimentation processes, fluvial geomorphology, and riparian rehabilitation and management.

Gary Rosenlieb: Water Quality Program Team Leader, MS in Water Resources. Specialty areas include water quality (chemistry and micro-biology), groundwater quality, and hazardous materials management.

Bill Werrell: Hydrology Program Team Leader, MS in Geology, MS in Hydrology. Specialty areas include well-siting, well design and testing, aquifer analyses, springflow monitoring, and floodplain management.

Gary Smillie: Hydrologist/Hydraulic Engineer, MS in Civil Engineering. Specialty areas include flood-frequency analysis, open-channel hydraulics, floodplain management, and sediment transport.

Larry Martin: Hydrologist, MS in Hydrology. Specialty areas include watershed management, riparian management, ground water modeling, GIS applications in water resources, and hydrologic data analysis.

Rick Inglis: Hydrologist, BS in Watershed Science. Specialty areas include field hydrologic data collection using automated recorders, watershed management, ground water monitoring, and data analysis.

Dean Tucker: Research Associate, PhD (pending) in Natural Resources (GIS). Specialty areas include data management, computer graphics, and water resources applications in GIS.

Barry Long: BS in Watershed Sciences, MS in Forest Hydrology. Specialty ares include physical-chemical aspects of water quality.

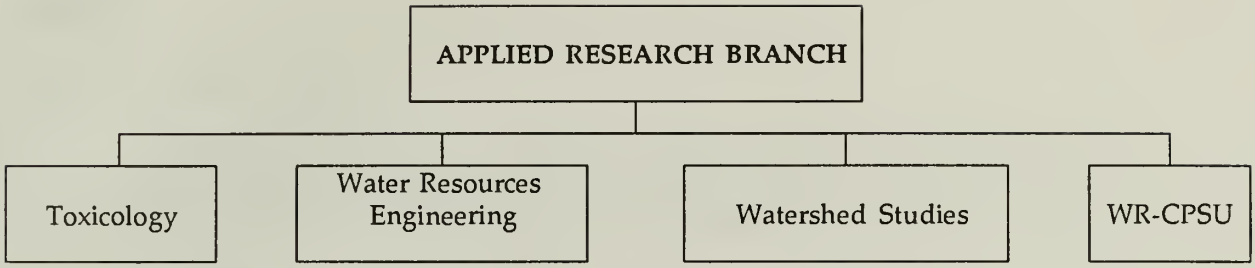
Jacquie Nolan: Cartographer/Computer Assistant, MA in International Relations. Specialty areas inlclude map preparation (including floodplain maps), graphics, and publications. Oversees Division Reference Room (which contains comprehensive water resources files for all NPS units).

Water Quality Specialist (Vacant): Specialist in biological aspects of water quality (including bio-monitoring).

Dianne Gibson: Secretary.

APPLIED RESEARCH BRANCH

Organization and Staff



Gerald Walsh: Branch Chief, PhD in Zoology/Aquatic Biology. Specialty areas include aquatic toxicology and aquatic ecology.

Marshall Flug: Research Hydrologist, PhD in Water Resource Engineering. Specialty areas include application of computer and mathematical techniques for management of water resources.

Raymond Herrmann: Unit Leader, WR-CPSU, PhD in Geology/Hydrogeology. Specialty areas include long-term ecosystem health, hydrologic cycle, and chemical flux in watersheds.

Robert Stottlemyer: Research Ecologist, PhD in Forest Soils/Biogeochemical Cycling. Specialty areas include long-term effects of anthropic atmospheric deposition in watersheds and long-term studies on snowpack nutrient dynamics.

Terence Boyle: Research Ecologist, PhD in Biological Sciences. Specialty areas include application of biological assessment techniques to water resource problems.

Del Wayne Nimmo: Environmental Chemist, PhD in Zoology/Limnology. Specialty areas include risk assessment related to non-point source pollution.

Jill Baron: Research Ecologist, MS in Land Resources. Specialty areas include long-term studies on effects of climate change on water resources in watersheds.

Terri Craig: Graduate Research Assistant; CSU. Specialty areas include studies on geology, sedimentology, and geomorphology of water resources.

Gustavo Diaz: Research Associate; CSU. Specialty areas include hydrological monitoring.

Robert Edwards: Research Associate; CSU. Specialty areas include long-term studies on effects of climate change in watersheds.

Nancy Hoefs: Research Associate; CSU. Specialty areas include biological assessment of water resources.

Secretary: Vacant

AWARDS

Water Resources Division

The Division received a Certificate of Appreciation award from the Western Region in recognition for exemplary assistance and contributions to the Division of Natural Resources and Research.

Office of the Division Chief

Debi Cox received a Performance Award (Quality Step Increase) for sustained high performance for calendar year 1990.

Peggy Matti received a Fast Track Award for her assistance in compiling the course notebooks for the Natural Resources Management Training Course held in Fort Collins, in May 1991.

Judy Rouse received a Special Achievement Award for her support of the Program Analyst position during Debi Cox's maternity leave.

Applied Research Branch

Jill Baron was named "Scientist of the Year" for the Washington Office.

Planning and Evaluation Branch

Joel Wagner received a Special Achievement Award for his significant contributions in the development and implementation of the Wetlands Activity Component of the WRD's Watershed Protection Program.

Barbara West received a Fast Track Award for her work on the Bi-National Lake Superior Task Force.

Water Operations Branch

Bill Jackson received a Department Superior Service Award for his contribution to developing the technical and programmatic capabilities of the Water Operations Branch.

Rick Inglis received a Special Achievement Award for his initiative in handling special assignments in the Glen Canyon Environmental Studies.

Bill Werrell received a Performance Award for his efforts in coordinating the Natural Resources Management Trainee Program of the Water Resources Course, for participating as a team leader for the Glen Canyon Environmental Beach Erosion Studies, and his involvement as a team member in modifying the NPS Floodplain Management Guidelines.

Water Rights Branch

Paul Christensen received a Fast Track Award for his outstanding work performance in support of the NPS protests to water right applications filed by the Las Vegas Valley Water District.

Dan McGlothlin received a Fast Track Award in recognition of his high level of quality effort in coordinating activities within the WRB and among the WRB, Western Region, Parks, Office of the Solicitor, and other Interior bureaus concerning case preparation with respect to the water right applications by Las Vegas Valley Water District.

Chuck Pettee received a Fast Track Award for his high level and quality efforts in computing flow regimes at Black Canyon of the Gunnison National Monument for use in litigation and in the development of a water delivery contract with the Bureau of Reclamation, and for providing a high level of technical support in assisting the Rocky Mountain Regional Director, and in presenting information to state, private, and Federal entities.

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The Merced River, Yosemite National Park. (Photo by W.L. Jackson)

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

February 1991